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EXTENSIONS TO THE MANHATTAN ELEVATED railway lines in New York city were proposed at an informal meeting of the committee of the directors of that company with the Rapid Transit Commission on June 4. The extensions suggested are a line along the North River reaching the principal ferries and connecting by cross-town spurs with the north and south lines of the system; an extension in the north part of the city, from 108th St. up Tenth Ave. or the Boulevard to 192d St.; an extension on the east side, from 149th St. along the Westchester road to the Bronx River, and eventually to West Farms, and an extension from 177th St., the present terminus of the Suburban Rapid Transit Ry., to the city limits. It is also proposed to build two additional tracks on the Bowery; one on Third Ave., one on Second Ave. and one on Ninth Ave., for the use of express trains. The extensions on the north part of the city are somewhat indefinite. The other improvements are promised at once, if the approval of the city authorities is given. The Manhattan directors also stated that "a change to electricity or compressed air for the road's motive power is under consideration," and that the company will not ask the city to guarantee it against suits for damages by abutting property holders. A formal application for permission to make the above extensions or some part thereof will be made by the Manhattan Co. in a short time.

ELECTRIC LIGHTING FOR PASSENGER CARS from storage batteries is giving good satisfaction on the Cape Government Railways, and is in use on the through express trains between Cape Town and Johannesburg, making a round trip of nearly 2,000 miles. At present three nights are occupied on the journey, and in some cases the lights have failed on the third night owing to the exhaustion of the supply of electricity, but a 48-hours' service is proposed for the new train. The report of the General Manager for 1895 states that a trial of direct lighting with a dynamo driven by an oil engine in the baggage car has been in progress for some months, with such success as to indicate that the use of accumulators for through trains may be dispensed with. Some accumulators will still be required, however, to supply the current when the train is not running.

RAILWAY TRAFFIC OVER FLOODED TRACKS was carried on by the Missouri, Kansas & Texas Ry., near Schell City, Mo., during the last two weeks of May. The Osage and other rivers had overflowed their banks, and for about three miles the track was covered by a running stream of water 20 to 30 ins. deep. Sandbags were piled on the ends of the ties and the slope of the ballast to prevent the current from washing out the roadbed, and no trains were stopped, the track being of course carefully watched.

AN INTERLOCKING PLANT is being put in at Scarboro, Me., at the crossing of the Eastern and Western divisions of the Boston & Maine R. R. There is a heavy traffic at this crossing, and hitherto all freight and passenger trains have been required to come to a full stop before reaching it, thus causing considerable delay and inconvenience. The new plant is being put in by the Union Switch & Signal Co., of Swissvale, Pa.

AUTOMATIC BLOCK SIGNALS have been installed between Gap Junction and Bethlehem, Pa., on the Lehigh Valley R. R., thus completing the equipment from New York to Bethlehem, 89¼ miles. The work has been done by the Hall Signal Co., of New York city.

THE ATLANTIC AVENUE TUNNEL, in Brooklyn, N. Y., which was intended to give the Long Island R. R. access to the Atlantic Ave. ferry for New York, was built in 1844, and abandoned in 1861, when a law was passed forbidding the use of steam cars on the avenue west of Flatbush Ave. The tunnel was double track, 2,800 ft. long, extending from Columbia St. to Boerum Place, and the grade was about 1%. Mr. Orlando Vibbard was the engineer and Beard & Collins were the contractors. Mr. A. P. Wilds was in charge of the track, which was laid with T-rails secured by keys in iron chairs. Numerous plans have been proposed for the utilization of the old tunnel (the approaches to which are filled in and paved over). A commission has recently been appointed by the mayor to consider the practicability of lowering or raising the Long Island R. R. tracks from the Flatbush Ave. terminal station, as these tracks now extend eastward along the surface of Atlantic Ave. all the way to East New York, and have numerous dangerous street crossings.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was the derailment of a passenger train on the Northern Pacific R. R., near Grey Cliff, Mont., June 2. Three tramps were killed and some of the trainmen were hurt, but all the passengers escaped injury.

A LOCOMOTIVE BOILER EXPLOSION occurred on the Rio Grande Western R. R. May 27, the crown sheet collapsing while the engine was hauling a local freight train between Helper and Grand Junction. Two trainmen were killed and the engineman and fireman were injured.

A DERAILED ELECTRIC CAR on the South Side branch of the Second Ave. Traction Co., Pittsburg, Pa., May 31, went over a 15-ft. embankment and landed on its roof, but fortunately nobody was killed. The car left the track at a sharp curve, and it is said that a broken wheel flange led to the derailment.

A RUNAWAY ELECTRIC CAR on the Nassau Electric Ry., Brooklyn, N. Y., caused a serious accident June 7. The car was an open one, and was ascending the 39th St. hill, when the trolley jumped off the wire (or, as the railway company claims, was pulled off by some mischievous person on the platform), and the car ran back down the hill, the motorman being unable to apply the brake with sufficient power to stop the car. One passenger was killed and about 20 injured, most of those seriously injured receiving their hurts by jumping from the car. At the bottom of the hill the car left the track and ran over to the sidewalk, where it was stopped by striking a telegraph pole. The car was jammed with people, about 130 riding inside and on the platforms and footboards.

THE FALL OF AN ELEVATOR in the works of the Friedenwald Printing Co., at Baltimore, Md., June 3, caused serious injuries to 13 persons, two of whom were probably fatally injured. The car had reached the fourth floor when the cable parted.

A FIRE ON THE THIRTY-THIRD STREET BRIDGE, at Pittsburg, Pa., June 3, caused considerable damage to the structure, and it was closed for traffic until repairs could be made. The bridge caught fire from some burning buildings of the Iron City Brewery, and a crowd of persons was on it at the time, watching the burning of the buildings. The crowd was so great that persons on the bridge had difficulty in getting off when the danger was discovered.

THE COLLAPSE OF THE BROWN BUILDING at Buffalo, N. Y., recorded in our issue of May 28, is being investigated, and some very curious evidence has been given. According to the press reports:

> A clause in the contract for the remodeling of the building provided that the work must be satisfactory to Mr. A. C. Esenwein, an architect, but Mr Esenwein swore that he did not know the clause was in the contract; that it was placed in it unknown to him and without his authority. He was not employed with reference to the alterations and had nothing to do with them. He said it was not proper to use the iron columns to support a weight of 60 or 80 tons. New piers should have been built or the weight should have been distributed over a larger surface. The shoring should have been left in until all the girders and columns had been placed. The finding of the crack in the division wall should have been followed by an examination as to how deep it extended into the brick work. The weight of the superstructure was unequally distributed on the old 16-in. wall. Robert Downing, foreman of the Kellogg Iron & Steel Co., testified that he superintended the putting in of the iron work. He swore that he was at work in the building when William P. Straub ordered the shoring knocked out and when the structure fell. He did not use face plates because they were not marked on the plan he used. They were provided for on the plan filed with the bureau of buildings. Mr. C. H. Kellogg testified that on five iron columns the saving in cost because of the decrease in size was $17.50. Barney Moppert, a brick mason, testified that he had remarked to Contractor Straub that the 12-in. iron plates on which the columns rested were too small. Straub told him that they had been sent and must be used.

THE NEW YORK & NEW JERSEY BRIDGE CO. held its annual meeting June 2. The Secretary, Mr. C. H. Swan stated in his report that the locations of the bridge, the approaches and the union terminal station have been definitely fixed by the State Commissioners, the Secretary of War and the Sinking Fund Committee of New York city. A plan for raising the money for construction is said to be under the consideration of men who are arranging to form a syndicate for the advantageous negotiation of the bonds, but it is deemed best to await an improvement in the financial condition of the country before completing any definite financial operations. The state commission has under advisement the company's plan for a freight approach from the bridge at 59th St., down and along the docks of the North River to Pier 1. By that approach the railways could reach the docks and load from the car to the vessel and also deliver to the warehouses along the line. Freight stations could be situated at desirable points along the line accessible to shippers, thereby making short hauls for their merchandise from the store, and at less expense for cartage.

AN EAST RIVER TUNNEL between New York and Brooklyn is proposed by the New York & Brooklyn Ry. Co., which has recently been incorporated by Benjamin S. Henning, A. B Cornell, Irving Washburn and others, of New York city, with a capital stock of $20,000.

THE CORINTH SHIP CANAL is proving as unprofitable an enterprise as the Manchester, although on a smaller scale. In the last half of 1895 its total earnings were only $30,000, while its operating expenses and taxes amounted to about $35,000.

A FAST TRANSATLANTIC RUN was finished by the steamer "St. Paul," of the American Line, on June 5, beating its former record by 3 h. 33 mins. The vessel left Southampton on May 20, passing the Needles at 1.35 p. m., and passed Sandy Hook at 2.07 p. m., June 5, having made the run of 3,113 miles in 6 d. 5 h. 32 mins. The daily runs were 488, 522, 522, 513, 508, 519, and 41 knots, and the average speed was 20.82 knots an hour. On the previous westward trip, when the record was lowered to 6 d. 9 h. 5 mins. (Eng. News, May 21), the vessel covered 3,112 knots, and made an average speed of 20.34 knots an hour. The two fastest days' runs made on the trip just completed were 521.9 and 521.7 knots, on June 1 and 2, when an average speed of 21.01 knots was maintained. The highest speed recorded was 21.03 knots per hour. An average steam pressure of 200 lbs. per sq. in. was maintained, and the average revolutions of the screws was 89¼ a minute. On the two biggest days' runs the average was 90.3 revolutions per minute.

THE BATTLESHIP "OREGON" has been found to have some defective plating in the protective deck, two plates 1½ and ¼ in. thick having been used instead of one 1¾-in. plate. An investigation has been made, and the superintendent of the Union Iron Works, of San Francisco, stated that this was done on his own responsibility, as he had not the 1¾-in. plates in the yard, and did not believe any injury was being done, as the deck was already made up of three thicknesses of plate. The builders will cut out the built-up plates and replace them with single plates of the specified thickness.

A THIRD HYDRAULIC DREDGE for the Mississippi River Commission is to be built by the Bucyrus Steam Shovel & Dredge Co., of South Milwaukee, Wis., Mr. A. W. Robinson, M. Am. Soc. C. E., Chief Engineer. This dredge is to have a capacity of about 2,500 cu. yds. per hour and will have one 24-in. centrifugal dredging pump directly connected to compound engines of 700 HP. The hull will be of steel 138 ft. long, 38 ft. wide, 8 ft. deep, and it will be provided with all complete appliances for operating the dredge, including quarters for officers and crew. There will be two suction pipes in front capable of making a cut 30 ft. wide at one time and the agitation of the sand will be by water jets when necessary. The material will be carried off through a floating discharge pipe 1,000 ft. long and will be discharged to one side of the channel.

THE JUSTIN DYNAMITE SHELLS, which are intended to be fired by powder charges from ordinary guns, were tested recently at Oneida Lake, N. Y., being fired from a 6-in. breech loading rifle and a 9-in. Blakely rifle. A 6-in. shell weighing 100 lbs. and carrying 4¼ lbs. of explosive gelatine burst during its flight; and a 9-in. shell with 34 lbs. of explosive, designed to explode after perforating the target, burst before reaching the target. These unsatisfactory results are attributed to the use of quick-burning instead of slow-burning powder, and a new test will be made by the Ordnance Bureau.

LITIGATION OVER ELECTRICAL PATENTS will be greatly reduced as a result of the agreement entered into between the General Electric Co. and the Westinghouse Electric & Mfg. Co. About 300 cases were brought between the companies, and hardly 20 had been tried, but these had involved enormous expense. In consequence of the agreement for the exchange of licenses these suits have all been withdrawn.

A PHOTOGRAPH OF A TORNADO.

The accompanying photograph of a tornado will be examined with especial interest at this time, we are sure, by those of our readers who have never had the fortune (good or ill) to witness one of these terrible storms. We are indebted for the photograph from which our cut is reproduced to the courtesy of Mr. C. D. Purdon, M. Am. Soc. C. E., Principal Assistant Engineer of the Atchison, Topeka & Santa Fe R. R., who informs us that the picture was taken by Mr. T. Croft, a local photographer, at Oklahoma City, Oklahoma Territory, at about 4 p. m., on May 14. The tornado was about six miles distant when the photograph was taken, and a rough computation indicates a probable diameter of the funnel of about 1,000 ft.

Photograph of a Tornado taken at Oklahoma City, May 14, at 4 p. m.

The photograph is, unfortunately, exceedingly faint, and the reproduction should show the sky much darker than it does; but it will doubtless be understood that a tornado is a difficult subject to photograph at the best; in fact, most people who have witnessed one of these twisters have found other things to occupy their time than taking pictures of the threatening spiral. So far as we are aware this is the first actual photograph of a tornado ever published, and we know of only one other ever having been taken. This is referred to on p. 127 of Russell's "Meteorology" as having been secured at Howard Mines Company, South Dakota, on Aug. 28, 1884, the cloud having been 22 miles away; and a rather poor pen picture is inserted, drawn from the photograph. So far as we know, therefore, the accompanying cut is the first direct reproduction of a tornado photograph ever published.

ACCIDENTS TO VESSELS OF THE U. S. NAVY IN SIX YEARS.

The following is a list of the accidents to Naval vessels during the past six years as reported by the Bureau of Construction and Steam Engineering of the Navy Department, in response to a Senate resolution. We print the list as published in the "New York Tribune," but it seems likely that it is incomplete, and that many of the minor accidents which have occurred in the Steam Engineering Bureau at least are omitted. It is, of course, difficult to draw the line and say at what point an accident becomes of sufficient moment to deserve inclusion in such a list. We do not see, however, why so serious an accident as the steam pipe explosion in the "Concord," in June, 1891, which resulted in several deaths, should have been omitted from the list, and this tends to confirm our suspicion that it is not a complete one. We reprint the table, however, for what it may be worth:

INJURIES TO NAVAL VESSELS IN SIX YEARS.

Reported by the Bureau of Construction.

Vessel.	Place.	Cause.	Cost.
Minnesota	Wallabout Channel, New York	Drifted against Enterprise	$240.00
Enterprise	Wallabout Channel, New York	Struck by Nina	240.00
Nina	New London	Struck by New Hampshire	258.00
Nina	New York	Collided with ferryboat Maryland	27.80
Triton	On trip to Annapolis	Collided with ordnance barge	35.00
Nina	Off Gayhead Light	Grounded	3,000.00
Galena	Off Gayhead Light	Grounded	Beyond repair
Despatch	Assateague, Va.	Grounded	Total loss
Vesuvius	At Anchor, North River, ft. 36th St., N. Y. City	Struck by a tow of barges	558.82
Chicago	At anchor North River, opp. 27th St., N. Y City	Struck by ferryboat Kingston	562.50
Atlanta	Hampton Roads	Collision with Jamestown (Jamestown grounded and fouled Atlanta)	1,258.47
Fern	———	Collision	4,025.00
Alliance	Yokohama	Grounded	37.25
Fern	Portsmouth, N. H.	Collided with Monongahela	419.00
Monongahela	At anchor, Portsmouth, N. H.	Collided with Fern	272.56
Philadelphia	Navy Yard, New York	Grounded while at wharf	65.00
Monongahela	Funchal, Madeira	Collided with Norwegian bark Speranza	2,180.82
Monterey	Mare Island, Cal.	Collided with ferryboat Ellen	535.00
Ellen	Mare Island, Cal.	Collided with Monterey	200.00
Dolphin	At anchor, New London, Conn.	During gale dragged anchor and collided with schooner J. Nickerson	250.00
Kearsarge	Roncador Reef	Grounded	———
Columbia	Near Philadelphia	Struck sunken rock	10,036.47
Chicago	European station	Collided with Azov	8,402.00
Columbia	At Southampton, England	Injured while docked	1,762.68
Alert	Guayaquil	Collided with British ship Condor	5,969.35
Monterey	At anchor off Seattle	Collided with Norwegian steamer Transit	5,000.00

Reported by the Bureau of Steam Engineering.

Vessel.	Description.	Cause.	Cost.
Boston	Crank shaft out of line	Ship grounding	$1,304.93
Petrel	L. P. valve gear broken on full power trial.	Previously strained on contractor's trial	870.33
Chicago	H. P. crosshead guide found cracked	Faulty design	196.25
Miantonomoh	Crown sheets of one boiler came down	Low water, due to neglect of attendant	3,411.72
Montgomery	P. H. P. engine wrecked	Loosening of set screw of one connecting rod nut.	2,016.93
Ranger	Core plug in piston dropped out, piston rod, etc., damaged	Not properly secured	992.02
Castine	Air pump piston broke	Water in cylinder	73.00
Cincinnati	S. I. P. valve rod broke	Excessve stress, caused by coating of hardened grease and oxide of iron in valve chest evidently from boilers	———
Indiana	S. H. P valve rod bent	Probably from same cause as above	———

NEW FREIGHT CARS FOR THE BALTIMORE & OHIO R. R.

The Baltimore & Ohio R. R. has recently placed orders for 4,600 new freight cars, and we have received from Mr. E. W. Grieves, Superintendent of the Car Department, the drawings and specifications of the new box cars, class M—8. The drawings we shall publish later, but in the meanwhile we give a general description of the cars as taken from the specifications. The cars were designed by Mr. Grieves and Mr. Harvey Middleton, General Superintendent of Motive Power.

There are two side sills, four intermediate sills, and two center sills, all of yellow pine, and tenoned into the oak end sills, which latter have oak buffer blocks, 5×11¾ ins., 3 ft. 1 in. long, bolted to the face. All the sills (except end sills), posts, body braces, etc., are of yellow pine. The body bolsters are of composite construction, built up of three pieces of white oak, 4½×6½ ins., and two wrought-iron plates, ¾×6 ins.; they are trussed by 1-in. round rods, with 1⅛-in. upset ends, passing through the bolster and the intermediate sills. The bolster is cambered to allow ⅜-in. clearance between the side bearings of the body and truck. The tie timbers are 5×10 ins., and to these are secured the truss-rod bearings. There are four body truss-rods, 1¼ ins. diameter, with 1⅜-in. upset ends, the turnbuckles being locked by an oak strip 1½×3 ins., extending right across the car and secured by cotters inside the turnbuckles. The pairs of rods are 17 ins. apart, c. to c., and the inner rods 4 ft. 2 ins. apart.

The side framing consists of vertical posts and braces, with iron rods, all connected to the roof framing and sills. The flooring is of 1¾-in. planks, 5 to 8 ins. wide, laid crosswise and secured by 20-penny nails. The sheathing is of planks 3 to 4 ins. wide, tongued and grooved. The inside lining is of ⅞-in. plank, 4 to 6 ins. wide; this lining extends all around the car, from the side girth to within 2½ ins. from top of floor. The limit to which grain may be loaded in each car is marked by black lines 4 ft. 3 ins. from the floor for wheat and 4 ft 6½ ins. for corn. The ouside is painted in three coats of brown mineral paint, mixed with the best linseed oil and Japan dryer. The lettering is in white lead, and the ironwork is given one coat of asphaltum or smokestack black.

The draw timbers are 4×9½ ins., placed under the center sills and extending from the end sill to the body bolster. M. C. B. automatic couplers are used, and these are connected up to the American continuous drawbar.

The trucks have diamond frames with top arch bar 1¼×4 ins., lower arch bar 1×4 ins., and tie bar ⅝×4 ins. The spring plank is an inverted 12-in. channel iron, and the bolster is built up of two pieces of white oak 3½×11½ ins., one piece 6×11½ ins., and two plates ⅞×8 ins., 7 ft. 5 ins. long. The bolster is trussed by two 1¼-in. rods, upset to 1¼ ins. at the ends. A nest of four spiral springs is placed under each end of the bolster. The trucks are equipped with Westinghouse brakes, having shoes inside-hung from iron brake-beams. The wheels are of cast iron, pressed on the axle with an average pressure of 60,000 lbs. (not less than 50,000 nor more than 80,000 lbs.). The journal bearings are lined with soft metal and weigh not less than 12 lbs. each; and the dust guards are of yellow poplar or basswood, of the Stier pattern, placed in the journal boxes with felt next to the journal. The woodwork is painted with two coats of brown mineral paint (equal in quality to Prince's metallic paint), mixed with the best linseed oil and Japan dryer. All the iron work (including the faces of the wheels) is given one coat of asphaltum or smokestack black.

The general particulars and dimensions of the box cars and trucks are as follows:

Length over end sills	36 ft. 10 ins.
Over body sheathing	36 " 11¾ "
Over running board	38 " 5 "
Inside	36 " 0 "
Over couplers	40 " 1¼ "
Width over side sills	8 " 10 "
Over body sheathing	8 " 11¾ "
Inside (between girths)	8 " 2 "
Over eaves	9 " 7 "
Extreme (over bottom slides of doors)	9 " 8¾ "
Height from rail to c. line of coupler	2 " 10½ "
To eaves	12 " 6⅝ "
To running board	13 " 4⅝ "
To top of brake shaft	14 " 0½ "
From side sill to side plate	7 " 5½ "
From floor to carline	7 " 7¾ "
Doorway	7 ft. 3½ ins. × 5 ft. 6 ins.
Side sills	5 × 8 "
Intermediate sills	3½ × 8 "
Center sills	3½ × 9 "
End sills	8 × 10 "
Side framing rods, diameter	¾-in.
Side posts	3 × 5 ins.
End posts	4 × 5 "
Corner posts	5 × 5 "
Door posts	3 × 5 "
Body braces	3 × 5 "
End braces	4 × 4 "
Wheels, diameter	33 "
Wheel base, truck	5 ft. 0 "
Total	31 " 10 "
Distance c. to c. of trucks	26 " 10 "
Axles, c. to c. of journals	6 " 3 "
Diameter at middle	4⅝ "
At wheel seat	5⅜ "
Journals	4¼ × 8 "
Carrying capacity	60,000 lbs.

The total number of cars ordered, and the names of the builders are as follows: Box cars (2,300)—Missouri Car & Foundry Co., St. Louis, Mo., 1,000; Barney & Smith Car Co., Dayton, O., 800; Mt. Vernon Car Mfg. Co., Mount Vernon, Ill.,

500. Single-hopper gondola cars (900)—Michigan Peninsular Car Co., Detroit, Mich., 800; Pullman Car Co., Chicago, Ill., 100. Double-hopper gondola cars (1,400)—South Baltimore Car Works, Baltimore, Md., 1,000; Missouri Car & Foundry Co., St. Louis, Mo., 400. Total number, 4,600. The cars will have the Buckeye couplers, the Westinghouse brake, the American steel bolster on 500 box cars, the Schoen pressed steel bolster on all the other cars, and the Chicago metal roof on the box cars.

The following is an abstract of the specifications for material:

White Oak.—Free from large or defective knots, bark edges and heart shakes, heart not over 3 ins. diameter and in center of timber.

Yellow Pine.—Untapped, one face clear of sap, other sides to show not less than two-thirds heart; free from large or defective knots, wind or heart shakes, and injurious sap. For flooring, timber with a small percentage of red knots not larger than 1 in. will be accepted.

White Pine Siding.—Good quality, entirely free from heart shakes, black and defective knots, and blue sap. Will admit of a small percentage of small, sound, red knots not over ½-in., and of white sap on one face covering not more than one-quarter the thickness and not more than 1½ ins. wide on the surface.

Castings.—Test specimens, 1⅛ ins. diameter, 4½ ins. between shoulder, must show a tensile strength of not less than 20,000 lbs. Test specimens 1 in. sq., 13 ins. long, left rough, resting on supports 12 ins. apart, must stand five blows of a 10-lb. weight at the middle, the first blow having a fall of 12 ins, and the height of each succeeding blow increasing 1 in.

Journal Bearings.—Copper, 78 to 80%; tin, 9 to 11%; lead, 10 to 13%; impurities (zinc, iron, etc.), not to exceed 0.75%. Lead-lined bearings; lead, 94 to 96%; antimony, 3 to 5%; tin, 0.5 to 1.5%.

Steel Axles.—One axle of each heat subjected to a test of five blows of a 1,640-lb. hammer, falling 29 ft., striking midway between supports 3 ft. apart, the axle to be turned after each blow. The drop is 23 ft. for 4¼-in. axles, increasing 2 ft. for each ⅛-in. increase of diameter.

Cast-Iron Car Wheels.—One wheel from each 50 selected for test; placed flange downward on an anvil block weighing not less than 1,700 lbs., set on rubble masonry 2 ft. deep, and having three supports not more than 5 ins. wide, for the wheel to rest on. It shall be struck centrally on the hub by a 140-lb. weight, falling 12 ft. Should it break in two or more pieces after eight blows, or less, the 50 wheels will be rejected.

THE EFFICIENCY OF A STEAM BOILER. WHAT IS IT?*

By William Kent,** M. Am. Soc. M. E.

The following paper is offered as a contribution to the discussion of the subject of the efficiency of steam boilers, which was begun by Mr. F. W. Dean's paper, presented at the Detroit meeting in June of last year, and continued by Dr. Chas. E. Emery's paper, presented at the New York meeting in November.

What the owner of a boiler wants to know concerning its economy is, "How many pounds of water will it evaporate per pound of coal?" The economy of an engine is usually expressed in "pounds of water per hour per horse-power," and in "pounds of coal per hour per horse-power." Knowing the pounds of water per hour required by the engine, the pounds of water evaporated by the boiler per pound of coal, and the price of the coal, the engine owner can then figure the cost of fuel per hour per horse-power. Hence arises the necessity for the report of a boiler test stating the result in "pounds of water evaporated per pound of coal under actual conditions" (1).

For comparing different tests, however, the conditions of feed-water temperature and steam pressure must be reduced to a uniform standard; hence it is customary to reduce the result (1) to the "equivalent pounds of water from and at 212° per lb. of coal" (2).

But coals from any given district vary in percentages of moisture and ash (largely in moisture if transported during rainy weather); hence for a further reduction to a standard of comparison we divide the result (2) by the percentage remaining after deducting the percentage of moisture (determined by drying a large sample, say 100 lbs., at the time of the boiler test) and the percentage of "ash and refuse" (determined by weighing all the ash and refuse withdrawn from the furnace during the test). This gives us the "pounds of water evaporated from and at 212° per lb. of combustible" (3).

These three results have been included almost universally in the reports of all boiler tests that have been published both in this country and in Europe during the past fifty years or more.

Let us now consider two ideal boiler tests in which, after obtaining the ordinary results, pounds of water evaporated from and at 212° per lb. of coal and per lb. of combustible, we attempt to obtain the "efficiency." The coals are, say, Pocahontas, Coal A, and Indiana Block, Coal B. The tests are made with the same boiler, and under the same conditions as far as possible. The steam is assumed to be dry, saturated, and the temperature of the flue gases 500° F. The engineer, with no other apparatus than platform scales, tanks, thermometers and a steam gage, obtains the results.

	A	B	
Lbs. of water from and at 212° per lb. coal.	11.04	7.65	(1)

The sum of the "ash and refuse" obtained in the test, and the moisture obtained by drying a sample of the coal, is, A, 8%; B, 15%; making what the engineer calls combustible, A, 92%; B, 85%; and from this we obtain

	A	B	
Lbs. of water from and at 212° per lb. combustible	12.00	9.00	(2)

From results (2) the engineer, knowing what results are usually obtained with Pocahontas and with Indiana coals, can form a fair opinion as to whether the boiler is doing what it ought to do, and what changes in rate of driving, setting of furnace, method of firing, etc., may make it do a little better. Until the term "efficiency" had been introduced into guarantees it would also determine whether or not the boiler had filled its guarantee. The results (2) could also be compared with the published results of all the tests that have been made during the last fifty years, and conclusions could be drawn from the comparison.

From results (1) the boiler owner, knowing the price of the two coals, could determine which one was the most economical for him to buy, and the fuel cost per horse-power per day. Thus far, all the work has been done by the engineer with ordinary apparatus, and neither the chemist nor the fuel calorimeter expert, necessarily involving additional expense, has been called in. But the "efficiency" of the boiler is desired. How shall we obtain it?

The first thing required is a sample of the coal used during the test. Who knows whether the sample taken is a correct average of the coal used in the test, or how much it is air-dried during the process of accumulating the sample barrelful, during the quartering, or during the subsequent transportation, mixing, quartering, etc., to which it is subjected before the chemical or the calorimeter test is made? The error of the sample may be two or three per cent. or more.

The chemist reports his analysis as follows:

	A, Pocahontas.	B, Indiana Block
Carbon	86.51	72.94
Hydrogen	4.44	4.50
Oxygen	4.95	11.77
Nitrogen	0.66	1.79
Sulphur	0.61	....
Ash	1.54	4.50
Moisture	1.29	4.50
	100.00	100.00

Calculated by Dulong's formula:

$$\text{B. T. U.} = 14{,}500\left[C + 4.28\left(H - \frac{O}{8}\right)\right],$$

the heating power of the coals is, A, 14,915; B, 12,457 (3).

Subtracting the ash and moisture, 2.83% in A, and 9% in B, we obtain:

	A	B	
Heating power of the "combustible"	15,349	13,689	(4)

Let us suppose that the fuel calorimeter man, by accident, also finds that his samples contain respectively 2.83 and 9% of ash and moisture, and he reports the heating value as follows:

	A	B	
Per lb. of coal	14,318	11,211	(5)
Per lb. of combustible	14,735	12,320	(6)

The heating power of A is 4% less, and that of B 10% less, than that calculated from the analysis. These differences between results calculated from analysis and those found by the calorimeter have actually been obtained by a chemist to whom Mr. F. W. Dean sent samples of coal of the same class, viz., Pocahontas. Scheerer-Kestner, however (see table in Dr. Emery's paper read at the last meeting, Nov., 1895), found the heating power of one coal (coking coal from Anzin) 18.8% greater by calorimeter test than that calculated from analysis; and in 19 coals tested by him found the calorimeter result greater in every case except one, which was 4.6% less. These variations in calorimeter tests certainly throw doubt on all calorimeter work until a sufficient number of tests shall have been made by different experimenters and with different calorimeters upon similar samples, and until tests so made show a reasonable degree of uniformity.

In the present state of our knowledge upon the subject, who is to decide which of the results (3), (4), (5), and (6) is to be accepted as accurate?

The engineer, having obtained these results, is now ready to make his calculations of the "efficiency" of the boiler. His own results he is sure of, within the ordinary limits of error of a boiler test. They are:

	A	B	
Pounds of water from and at 212° per lb. of coal	11.04	7.65	(1)
Pounds of water from and at 212° per lb. of combustible	12.00	9.00	(2)

Multiplying these figures by 965.7 he obtains the heat units absorbed by the boiler, as follows:

	A	B	
Heat units absorbed per lb. of coal	10,661	7,388	(7)
Heat units absorbed per lb. of combustible	11,588	8,691	(8)

Figuring first from coal, dividing (7) by (3), he obtains:

	A	B	
Efficiency (7) ÷ (3)	71.48%	59.31%	(9)
" (7) ÷ (5)	74.46%	65.90%	(10)

Figuring now from combustible, he obtains:

Efficiency (8) ÷ (4)	75.50%	63.49%	(11)
" (8) ÷ (6)	78.64%	70.54%	(12)

The results (9) and (10) express the ratio of the heat absorbed (including its moisture and ash) by the boiler to the heat units in the coal fed into the furnace. The results (11) and (12) express the ratio of the heat absorbed by the boiler to the heat units in the combustible portion of the coal that was burned in the furnace—that is, the coal fed minus the deduction for moisture and the refuse coal and ashes withdrawn from the furnace. The latter express the efficiency of the combustion of the boiler as an absorber of heat, and of the furnace as it more or less completely burns the combustible gases; the former the efficiency of the combination of the boiler, the furnace, the spaces between the grates which allow unburned coal to fall through them, and the method of stopping the test, by which a greater or less quantity of coal is withdrawn with the ashes. Can any one of them properly be called the efficiency of the boiler, and if so, which one? After the boiler owner has received the report of the results (9), (10), (11), and (12), how much wiser is he than he was when he received the report of results (1) and (2) only, with the comparison of these results with those observed from other boilers using the same kinds of coal? Can he with these later results figure any closer than before the cost of fuel per horse-power, or does he know any more about the relative values of different boilers, or different kind sof fuel? If these results have any value, is it sufficient to warrant the engineer asking the boiler owner to go to the expense of having chemical analyses and calorimeter tests made?

Enough has been said to show the uncertainty, in the present state of our knowledge, of the accuracy of tests by the fuel calorimeter. Are we any more certain of the results of ultimate chemical analysis?

Comparative accuracy in iron and steel analysis has only been attained after years of experiment and comparison of results obtained by different chemists. I have yet to learn of any duplicate samples of coal having been analyzed by two or more different chemists for the purpose of checking results. Until this is done, and until more definite information in regard to the accuracy of analysis of coal is obtained than we now have any analysis must be open to more or less suspicion of inaccuracy.

Another objection which may be made to the use of "efficiency" as a standard in commercial boiler tests is the following: In boiler tests made to compare two competing boilers, or to determine the fulfillment of a guarantee, when there is a premium or a forfeit at stake, there are usually two parties to the test, whose interests are antagonistic, the competing boiler makers or the boiler maker and the purchaser. In the ordinary test in which the evaporation per pound of combustible is the standard, the boiler maker has the privilege of using the best coal he can obtain of the kind named in the contract, and both parties are represented at the test by experts who check the accuracy of every recorded observation. There is no difficulty in their obtaining identical results, for the platform scales, tanks and other instruments, are standardized, and the weights and measurements are easily verified. But when "efficiency" is adopted as a standard, who is to verify the work of the chemist, or who shall determine the accuracy of the fuel calorimeter? When ores are purchased on certified chemical analysis, the chemist himself or his representative, as a disinterested party, does the sampling, but in a boiler test the chemist or the calorimeter expert merely certifies that the particular sample which has been sent to him "as received" has such a chemical analysis or such a heating value. There is no check upon his work, and each party to the test takes the risk of his inaccuracy, which may be serious.

I am informed that in a recent boiler test at St. Louis a boiler maker was subjected to a forfeiture of several thousand dollars as a result of his failing to show a certain guaranteed "efficiency." I think it more than probable that if the coal used in that test had been differently sampled, and if its heating value had been determined by a different chemist or by a different calorimeter, the amount of the forfeiture would have been greatly diminished.

The agitation in favor of the use of the "efficiency" of boilers as a standard of comparison has already extended so far that some engineers who frame specifications for contracts are including "efficiency" as among the things to be guaranteed. Two examples of this have recently come under my notice. The first specifies that "the contractors are to state the efficiency they will guarantee

*Abstract of a paper presented at the St. Louis meeting May, 1896, of the American Society of Mechanical Engineers.

**Associate Editor, Engineering News.

from coal having a calorific value of 12,000 B. T. U.; if fuel with different calorific value is used in making the test, correction will be made." The second worded the specification to the effect that contractors will be required to state the efficiency they will guarantee from the coal now being used in the works, Illinois screenings; the efficiency to be computed from coal and not from combustible; and the coal will have a calorific value of not less than 10,500 B. T. U.

In neither case was any definite information given concerning the nature of the coal to be used in the test, nor was it stated whether the calorific value was to be determined by analysis or by calorimeter, or by whose calorimeter. The boiler-maker who bids on such a specication is taking a gambling risk. He not only has to fix his price on the usual basis of cost plus profit, modified possibly by his anxiety to get the job and by his opinion as to what competition he is to meet, but he has to guess at what kind of guarantee his competitors will give knowing that the competitor who knows the least about actual boiler tests with Western coals will be apt to give the highest guarantee. My own opinion is that not enough is yet known concerning the calorific power of Western coals, concerning the method of determining their calorific power, nor concerning the "efficiency" of boilers, to warrant efficiency being considered as an accurate standard of comparison, nor of its being specified in guarantees. I would especially condemn the particular method of specifying it which is used in the two examples given above. If an engineer believes that "efficiency" is a proper standard for bidders to be governed by and to guarantee, then he should state in his specifications what kind of coal will be used in the test, what percentage of efficiency is required, and how the efficiency is to be determined; if by analysis, by what chemist, and if by calorimeter, by whose calorimeter.

I have no objection whatever to the use of the term "efficiency" in reports of boiler tests, whenever the heating value of the coal can be determined, whether by analysis or by calorimeter. A knowledge of the efficiency may be of great value for scientific study of comparative boiler-tests by the boiler-maker and by the engineer, and the efficiency may be conveniently recorded in the result of a test as an addition to the time-honored evaporation per pound of coal and per pound of combustible, but I would by no means substitute it for these results, and especially I would not advise its adoption as a commercial standard to be specified in contracts or in guarantees.

Since the above was put in type, I have received the results of calorimetric tests, by two different calorimeters, of two coals which I recently used in testing a boiler. One coal (C) was from Jackson Co., Ohio, and the other (D) was from New River, W. Va. The results obtained in the boiler tests were as follows:

	C.	D.	
Water evaporated per lb. coal, actual conditions.....lbs.	6.793	9.649	(1)
Water evaporated per lb. from and at 212°.....lbs.	8.188	11.618	(2)
Water evaporated per lb. combustible 212°.....lbs.	8.577	12.252	(3)
Ash and refuse, per cent.	4.527	5.158	(4)
Heat absorbed by the boiler, per lb. coal.....B. T. U.	7,907	11,220	(5)
Heat absorbed by the boiler, per lb. combustible.....B. T. U.	8,283	11,853	(6)

The results of the calorimeter tests are as follows:

	C.	D.	
Heat units per lb. coal, Carpenter cal. B. T. U.	13,170	15,200	(7)
Heat units per lb. coal, Thompson cal. B. T. U.	11,913	13,996	(8)
Heat units per lb. combustible, Carpenter cal. B. T. U.	14,620	16,210	(9)
Heat units per lb. combustible, Thompson cal. B. T. U.	13,302	13,799	(10)
Difference between results (9) and (10). B. T. U.	1,318	2,411	
Difference per cent of greater per cent.	9.02	14.87	

The "efficiency" of the boiler, as calculated from the above data, is as follows:

Figuring from coal:	C.	D.
Results, (5) ÷ (7) Carpenter calorimeter, %	60.04	73.82
Results, (5) ÷ (8) Thompson calorimeter, %	66.37	85.83
Figuring from combustible:		
Results, (6) ÷ (9) Carpenter calorimeter, %	56.66	73.12
Results, (6) ÷ (10) Thompson calorimeter, %	62.27	85.17

As the above record stands, the "efficiency" of the boiler may be anywhere from 56.66 to 85.83%, according to how the results are calculated and what calorimeter is used. The high figures, 85.17 and 85.33%, might be useful for advertising purposes, and they suggest that the way to get a high "efficiency" for a steam boiler is to use the Thompson calorimeter to determine the heating value of the fuel, but they are utterly untrustworthy.

These calculations, I submit, demonstrate the total unreliability of the "efficiency," as at present determined, for a commercial standard for boiler tests.

NOVEL DESIGN FOR A POWER HAMMER.

The design of a power hammer, in which the moving weight or drop is required to be lifted and let fall with exceeding rapidity is a problem of no small difficulty. It is an easy enough matter to raise by power a 150-lb. weight and to let it fall, but to pick it up and raise it to its full height in a small fraction of a second involves the overcoming of the inertia of the heavy mass, which, if done too suddenly, is sure to break some part of the lifting mechanism. To avoid this difficulty it has been customary to insert something of an elastic nature between the lifting rod and the drop such as a leather strap, spiral or other springs, rubber, etc. We illustrate herewith a power hammer in which the desired result is obtained without the use of either of these devices. It is known as the Beaudry Champion Power Hammer and is built by Beaudry & Co., 45 Oliver St., Boston, Mass. In this hammer the power is obtained by a short belt with 12-in. bearings,

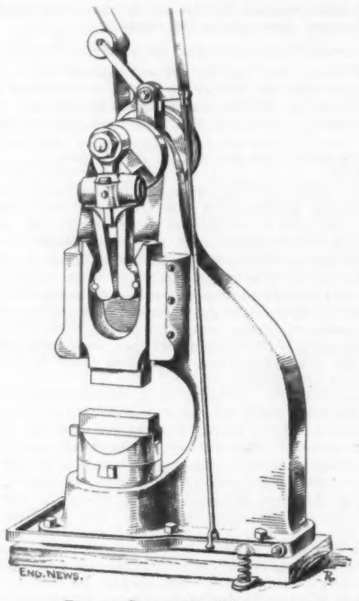


Fig. 1.—Perspective View.

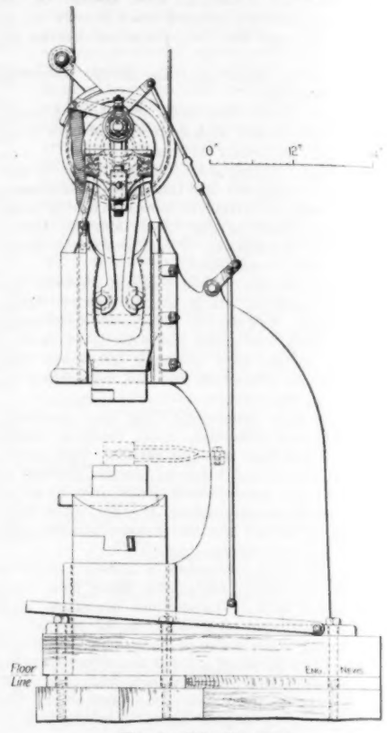


Fig. 2.—Side Elevation.

POWER HAMMER. BUILT BY BEAUDRY & CO., BOSTON, MASS.

having at one end a heavy slotted disk carrying an adjustable eccentric pin to which is attached the rod, which can also be adjusted for short or long stroke. The rod slips through a spring box, which can, in turn, be instantly adjusted. This box holds two arms provided with hardened steel rolls at their lower extremities, which run in a circular concave track and which serve to lift the ram, which is entirely independent of the machine by any other connection.

The peculiar construction of this circular concave track, combined with the action of the spring arm and rolls, imparts an elasticity to the ram which is better, it is claimed, than that secured through the medium of the various kinds of springs hitherto used. The ram is counterbalanced in the pulley to raise it to its highest position when stopped. The anvil sets through the frame, but is supported independent of it 6 ins. below the floor line on its own foundation. The ram spring arms, rolls and spring box are all made of steel.

The hammer is under complete control of the operator, and can be instantly adjusted so that the full stroke can be had on a piece 4 ins. square in section as readily as on a piece ½ in. thick. It can be made to run at the will of the operator at a high speed, and to deliver a blow of from 1 lb. up to the full capacity. The ram is made in weights from 150 to 200 lbs.

ENGLISH AND AMERICAN RAILWAY TRACK.

A somewhat extended discussion on the advantages and disadvantages of the English type of track with bull-head rails in cast-iron chairs has been going on in the London "Engineer" for some time past, and has received an added impetus by the recent fatal accident caused by the fracture of an old rail left in the main track of the Great Northern Ry., and a second accident at the same place due to imperfect ballasting when the damaged track was relaid. A few writers have had the courage to point out the advantages of the American type of track with T-rails secured directly to the ties and having steel tie-plates placed under the rails to protect the tie. It may be noted that these tie-plates are in no sense comparable with the chairs which are required to hold up bull-head rails, but are to be classed rather with preservative processes. The English objections to the American type of track are due mainly to prejudice and ignorance, very few English engineers being well posted as to the modern construction of track in the United States or the great wheel-loads, train loads, speeds, and heavy traffic carried by such track. The T-rails used in England in the early days of railways were of poor design, and consequently gave poor service, but any new line of railway in England could lay a T-rail track fully as substantial as the ordinary bull-head rail track at very much less cost for construction and maintenance. It has already been pointed out by one participator in the correspondence above referred to that no track in England is equal in point of easy riding to the American tracks laid with high stiff 100-lb. rails, while many American rails are actually stiffer than English rails of equal weight. One of the latest contributions to this correspondence, taken from the "Engineer" of May 22, we print below, as it is of interest in showing the result of actual experience with the English type of track as laid experimentally in this country. It may be noted that a short piece of this type of track, but with steel ties, is still in service on the Pennsylvania R. R., but has to be held in position by timbers placed between the ends of the steel ties and the ends of the wooden ties of the adjacent track. As to the number of ties per rail length, few American railways use as many as 18, the most common spacing being 15 to 17 per rail, while the Pennsylvania R. R. and some other lines use only 14, though this is hardly to be recommended, even with heavy rails. The letter above referred to is as follows:

In a recent leading article in the "Engineer" there appears the following statement:—"We have not the least hesitation in saying that a first-class road cannot be made with flanged rails spiked to cross-sleepers." It would have seemed to me that roads of this construction which carry, as do several in the United States, heavier trains at higher speeds than any which are run in this country, are at least high enough class for all practical purposes. But I did not take up my pen merely to say this. It occurred to me that the purport of a conversation I had last summer with two very distinguished American railway men, the one the president of one of the principal companies, the other the first vice-president of a yet

greater company, would be of interest to your readers in this connection. Here is a rough sketch of our dialogue.

Vice-President: Your roads won't do for our traffic.

W. M. A.: I don't understand.

Vice-President: They're not strong enough.

W. M. A.: Well, I always understood that our chair roads were accused of being extravagantly costly, but I thought they were admittedly better and stronger than your Vignoles system. Do you deny this?

Vice-President: Certainly I do. They possess no advantage to set against the increase of cost. And, mind you, I speak from experience. We took out from England two or three miles of standard Northwestern road, rails, chairs, fastenings, and everything complete. The only thing we did not import was the ties themselves. We took out likewise Northwestern permanent way hands, and they laid their own road in our main line alongside of our own standard pattern of road. And so we tested the two systems side by side. Your system not only was much more difficult to maintain, but was so knocked about by our heavy traffic that after a year or two we had to take it out, while our own road of the same age was still in perfectly good condition.

W. M. A.: Well, you surprise me.

Vice-President: The truth is, your chairs make too rigid and unyielding a road. Our system with the rails resting directly on the ties gives an elasticity that spares both road and rolling stock.

W. M. A.: Then if I understand rightly, your position is, that we are making just the same mistake that the old engineers made when they fastened their rails straight down on to granite blocks, or even in some cases direct on to the bed rock itself.

Vice-President: Precisely so, only of course in a less degree. I may say that we don't even use tie-plates, so that our rail rests direct on the soft elastic wood of the sleeper.

President: I quite agree with all that Mr. —— has said. Of course you must remember that we are not talking about the weak Vignoles rails with wide-spaced sleepers that one sees on the Continent, and that our roads are laid with about 90 lb. rails, and besides, have a tremendous lot of wood in them. You here in Europe put ten or eleven sleepers under a 30 ft. rail where we should put at least fifteen. In the main line my company have as many as sixteen or seventeen ties under each rail—in fact, I'm not sure whether we haven't lately gone as far as to use eighteen.

W. M. A.: Well, I must confess this is a perfectly new light to me. I should be interested to know what our English engineers would say to it.

Vice-President: Why, Mr. Eddy, who was trained on the English system, has come back from Australia a convert, and declares that chair-roads are a mistake.

Such, Sir, was the upshot of our conversation as accurately as I can remember it; and, as it made a great impression on me at the time, I do not think I am likely to be far wrong in my recollection. I do not, of course, presume to express any opinion of my own upon a technical subject. But I will just say this: English railway men fought hard against continuous automatic brakes; they have had to acknowledge themselves wrong. They fought hard against bogie carriages. Mr. Patrick Stirling probably died unconverted, but he has left no successor. Is it not possible that in standing out against the opinion of the civilized world—I ought perhaps to make an exception of the case of France—they are wrong also.

W. M. Acworth.

Some correspondents of the "Engineer," differing from Mr. Acworth, refer to the number of derailments on American railways and to the use tie-plates, which they evidently look upon as akin to the English chairs. In the first place, derailments on good track are probably no more numerous in this country than in England, while in the second place the tie-plate is in no sense to be classed with a chair, but rather as a tie preservative.

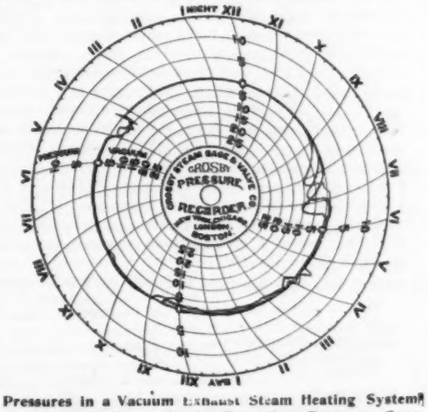
PRESSURE RECORDS FROM A VACUUM STEAM HEATING SYSTEM.

The appended diagram was taken by a Crosby pressure recorder from the main steam-heating pipe in the new building at the corner of Broadway and Broome St., New York city. This handsome structure, which was completed in March last, and is now known as the "Silk Exchange Building," was fitted with electric lighting, elevators and a steam-heating system to the specifications and plans of Mr. Reginald Pelham Bolton, who is also the engineer of the new Syndicate Building, on Liberty St., the Bowling Green Building and others. The building has a frontage east on Broadway of only 24 ft., but a northerly and exposed frontage on Broome St. of 196 ft., and attains a height of 142 ft., thus exposing a surface to northerly winds of nearly 28,000 sq. ft.

For the heating of this, about 8,500 sq. ft. of radiating surface is provided in 175 radiators, steam being at present taken from one of two Bigelow boilers of 90 HP. each, situated under the Mercer St. sidewalk.

The risers are eight in number, and the steam being received at the extreme end of the building, the distance it traverses on circulating through some of the radiators is upward of 600 ft.

The system adopted by Mr. Bolton is the Webster combination vacuum system, by which the return pipes from the radiators are connected and brought to a vapor pump, which delivers the hot water under suction to an open Webster feed heater and the air and vapors to the atmosphere at the roof. The result is an entire absence of back pressure when exhaust steam from engines or pumps is utilized, as may be readily seen from the



Pressures in a Vacuum Exhaust Steam Heating System as Shown by a Crosby Recording Pressure Gage, April 8, 9 and 10, 1896.

accompanying diagram, which shows the 24 hours' record during more than three consecutive days of this month, viz.: April 8, 9 and 10 and to 12 a. m. on the 11th. It illustrates the uniformity with which the pump can be made to control the circulation. The outside temperatures on April 8 varied from 29° to 44°, with a wind travel of 350 miles in all, being 11 hours from midnight of northerly, 1 hour changing and 11 hrs. 50 min. of N. W. wind.

The temperatures of the other days were: 9th, 33° to 48°; 10th, 35° to 45°; 11th, 35° to 48°. The outlet valve upon the radiators is of the thermostatic type, designed by the Warren-Webster Co. especially for Mr. Bolton's work. It requires no attention whatever on the part of the tenant. It automatically opens at the temperature of condensed water and closes at 212°, thus always maintaining steam in the radiator with entire absence of water hammer. The inlet valves are designed with extended spindles, by which means the tenant does not need to stoop to turn the hand-wheel, which is about 2 ft. from the floor.

The same system of circulation, with some modifications to suit circumstances, is now being fitted under Mr. Bolton's specifications to the two large buildings previously referred to, also to the Lords Court Building, in William St. and Exchange Pl., and to a large apartment hotel in Columbus Ave., which will be the first of its kind to receive these improvements.

STATISTICS OF THE IRON AND STEEL INDUSTRIES.

The general review of the domestic iron trade given in the annual report of the American Iron & Steel Association, refers to the favorable outlook noted in its last report (which was completed in April, 1895), and states that by May, 1895, industrial activity had been greatly stimulated, and that it was generally recognized that a revival of prosperity had actually commenced. The improvement in business conditions was most marked in the iron and steel industries, which had previously been experiencing very unfavorable conditions. In view of the coming advance in prices, railway companies and other consumers began to place orders freely, and soon afterwards the mills and furnaces were taxed to the utmost to meet the extraordinary demand. Prices continued to rise until September, when a reaction commenced, and prices then fell steadily until the end of the close of the year, although consumption continued active. In no other manufacturing industry was there such an extraordinary demand or such an advance in prices, although there was a general improvement of all trade conditions. Bessemer pig iron advanced from $9.95 per ton in January, to $17.75 in September, and Bessemer billets from $14.60 to $25. In steel rails, however, no decline in price marked the end of the year. In December, 1894, the price at Pennsylvania mills was reduced from $24 to $22 per ton; in June, 1895, it was restored to $24, and in September it was increased to $28, which has not since been changed. The iron and steel boom of 1895 was not caused by an extraordinary demand, differing in this respect from the boom of 1879 and 1880, which was almost wholly due to this cause.

The recovery of the iron and steel industries in 1895 from the depression of 1893 and 1894, was complete, and was remarkable in the magnitude of its results. In most branches, the largest production ever recorded was achieved in 1895, steel rails being the only notable exception.

During the first quarter of 1896 there was a slackening in the demand for these products, and this condition still prevails. Consumption is larger than it was at the beginning of 1895, but below that of the latter half of that year, while prices during the first quarter of 1896 were generally weaker than at the close of 1895. A ruinous shrinkage of prices, however, has thus far been prevented. The increase in prices in 1895 was accompanied by a general advance in wages of men in the coal, coke, iron and steel industries, this advance being voluntary on the part of the employers. The friendly relations between capital and labor in these industries still continues, wages being still maintained substantially on the basis established during the boom, in spite of the gerat decline in prices.

The accompanying Table I., compiled from tables and figures in the report, shows clearly and in convenient form the condition of the iron and steel industries, and allied industries, in 1895 and 1894.:

TABLE I.—Statistics of Iron Production in 1894 and 1895.

	1895.	1894.
Iron ore mined, gross tons	15,957,614	11,879,679
Shipped from L. Superior mines	10,438,268	7,748,932
Imported, gross tons,	524,153	168,541
Connellsville coke, net tons	8,244,438	5,454,451
Connellsville coke, average price	$1.20	$1.00
Pocahontas flat top coke, net tons	701,697	805,684
Anthracite coal, Penn., gross tons	46,511,477	41,391,200
Cumberland coal, gross tons	4,526,185	3,966,106
Bessemer steel ingots, gross tons	4,909,128	3,571,313
Open-hearth steel ingots & castgs.	1,137,182	784,936
Structural shapes, except plates	517,920	360,305
Plates and sheets	991,459	682,900
All rolled iron & steel, except rails	4,883,438	3,620,439
Bessemer steel rails	1,209,628	1,016,013
Open-hearth steel rails	697	1,085
Iron rails	5,810	4,674
All rails	1,306,135	1,021,772
Street rails (included above)	163,109	157,457
Pig iron, first half of year	4,087,558	2,717,983
Second half of year	5,358,750	3,939,405
Total	9,446,308	6,657,388
Bessemer	5,623,695	3,808,567
Imported	53,232	15,582
Nails:		
Cut, iron and steel, kegs 100 lbs	2,129,894	2,425,060
Wire, iron and steel, kegs 100 lbs.	5,841,403	5,681,801
Wire rods, iron & steel, gross tons	791,130	673,402
Tinplate, lbs. (year endg. June 30)	193,807,073	139,223,467
Miles of new railway	1,800	2,157
Locomotives built by companies	1,100	748
Freight cars built by companies	37,000	17,029
Iron and steel ships built*	43	39
Tonnage of above ships	48,504	51,470
Iron and steel imports, value	$25,772,136	$26,843,576
Exports, value	$35,062,828	$29,043,729
Coal, imports, gross tons	1,364,016	1,334,185
Exports, gross tons	3,682,693	3,636,341
Immigrants	324,330	250,313

*Exclusive of ships for the navy.

The report gives details of prices of iron and steel per month, and for a number of years, but for general purposes Table II., which gives average yearly prices of leading articles in Pennsylvania, will suffice. These prices are per gross ton, except that bar iron is quoted at a rate per 100 lbs.

TABLE II.—Average Prices of Principal Iron Products in Pennsylvania for Several Years.

	1892.	1893.	1894.	1895.
Old iron T-rails	$19.48	$16.43	$11.95	$14.09
No. 1 anthracite fdry. pig, Phila	15.75	14.52	12.06	13.10
Gray Forge pig, Philadelphia	13.54	12.73	10.73	11.49
Lake ore, Pittsburg	12.81	11.77	9.75	10.94
Bessemer pig iron, Pittsburg	14.37	12.87	11.38	12.72
Steel rails, Pennsylvania mills	30.00	28.12	24.00	24.33
Steel billets, at Pittsburg mills	26.63	20.44	16.58	18.48
Best refined bar iron, Phila.	1.87	1.70	1.34	1.44
Best refined bar iron, Pittsburg	1.64	1.50	1.20	1.25
Wire nails, Chicago	1.70	1.40	1.11	1.69

In tinplate, the imports increased from 215,068 gross tons ($12,053,167 foreign value) in 1894, to 219,545 tons ($11,482,380 foreign value) in 1895; Great Britain furnishing naturally all the tinplates imported since 1872, aggregating 4,823,992 tons ($379,492,793 foreign value). The foreign price has been steadily reduced by home competition, and during the first four months of 1896 the price of American I. C. full-weight tinplates at New York has averaged about 10 cts. below that quoted for similar grades of foreign tinplates. The wholesale prices of such imported plates, per box of full-weight, 108 lbs., coke Bessemer tinplates, I. C., 14×20 ins., at New York, with freight and duty paid, has ranged as follows:

Jan., 1890...$4.72	Jan., 1893...$5.35	Jan., 1896...$3.86
Jan., 1891... 5.35	Jan., 1894... 5.27	Feb., 1896... 3.88
Jan., 1892... 5.30	Jan., 1895... 3.96	Mar.,1896... 3.85

The average yearly circular prices of hard white ash anthracite coal, per gross ton, f. o. b., at Philadelphia, have been as follows for the five sizes given below:

	Lump.	Broken.	Egg.	Stove.	Chestnut.
1893	$3.90	$3.77	$3.97	$4.24½	$4.23
1894	3.90	3.83⅜	3.97½	4.18⅛	4.18⅛
1895	3.50	3.29	3.38	3.44	3.25

The prices of Lake Superior pig iron for 1895 show an increase over those of 1894, and are themselves exceeded by those for 1896. The lowest for Bessemer ore is $3 per gross ton for Marquette, while the highest is $4.90 for Lake Angeline extra low-phosphorus. The prices on the Mesabi are $3.75 and $3.25 for No. 1 and No. 2. Now Bessemer ore is at $2.60 to $3.25. The Juragua Iron Co. shipped 311,052 gross tons of ore from its Cuban mines to the United States in 1895, as against 160,613 tons in 1894. This was the first company to ship iron ore from Cuba to this country, and its total exports for 1884 to 1895 amounted to 2,527,777 tons. No ore was mined or shipped in 1894 or 1895 from the Cuban mines of the Sigua Iron Co., but the Spanish-American Iron Co., which commenced in 1895, shipped 74,992 tons.

Of standard Bessemer steel plants, 16 did not make steel in 1895; while 2 of the 3 Clapp-Griffiths steel plants and 1 of the 4 Roberts-Bessemer plants were idle. Since the last report, three new Bessemer plants (with 5 converters) have been established, and 5 plants (with 7 converters) have been abandoned. The production in 1895 was by far the largest of any year in the history of this industry in the United States.

Production of Iron and Steel in Canada.

The production of pig iron in Canada was first ascertained by the Association from the manufacturers for the year 1894, when it amounted to 44,791 gross tons. In 1895, according to reports from the Canadian manufacturers, the production amounted to 37,829 tons, a decrease of over 15%. About 16% of the production of 1895 was charcoal pig iron, the remainder being coke pig iron. The pig iron of Bessemer quality produced in 1895 amounted to 2,660 tons, the production being confined to one company. On December 31, 1895, the unsold stock of pig iron in the hands of the manufacturers or their agents amounted to 17,800 tons, of which a little over 40% was charcoal pig iron, the remainder being coke pig iron. At the end of 1895, there were 8 completed blast furnaces, of which 4 were in blast and 4 out of blast on Dec. 31. A furnace reported as being built at Hamilton, Ont., in 1894, was completed late in 1895, but the blast was not applied until February, 1896.

The production of crude steel and of iron and steel rolled into finished forms last year was as follows: Open hearth steel ingots, all made by the acid process, 17,000 gross tons; rails, 600 tons; structural shapes, 4,560 tons; cut nails, made by rolling mills and steel works having cut-nail factories connected with their plants, 208,042 kegs of 100 lbs.; plates and sheets, 655 tons; all other rolled products, excluding muck and scrap bar, 61,200 tons. Changing the cut-nail production from kegs of 100 lbs. to gross tons of 2,240 lbs. the total quantity of all kinds of iron and steel rolled into finished products in Canada in 1895, excluding muck and scrap bar, amounted to 66,402 tons. The Nova Scotia Steel Co., of New Glasgow, made all the steel produced in 1895. The total number of rolling mills and steel works in Canada on Dec. 31, 1895, was 15, and in addition 1 rolling mill was being built, which has since been completed. Of the completed plants several were idle during the whole of 1895.

Foreign Statistics.

	1895.	1894.
Germany, pig iron, metric tons....	5,788,798	5,380,038
France, pig iron, metric tons	2,005,889	2,069,714
Sweden, pig iron, metric tons.....	462,800	453,421
Belgium, pig iron, metric tons.....	829,135	818,597
Belgium, finished steel, metric tons	392,332	341,318
Great Britain (first half of year):		
Pig iron, gross tons	3,721,870	3,668,270
Bessemer steel ingots, gross tons	801,860	810,392
Open-hrth steel ingots, gross tons	887,000	1,029,409

As supplementary to the foregoing review of the iron and steel trades, we have compiled in Table III. a list of iron and steel works from the "Directory to the Iron and Steel Works of the United States," for 1896, which is published by the American Iron & Steel Association. During the two years which have elapsed since the last edition of this directory a very large number of entirely new iron and steel enterprises have been undertaken, among which sheet mills and tinplate works are the most prominent. Canada is reported as having 8 blast furnaces, of which 4 use coke and 4 use charcoal; 15 completed rolling mills, 1 of which makes open hearth steel, and 1 rolling mill under construction. Mexico is reported as having 14 blast furnaces, of which 13 use charcoal and 1 uses coke and charcoal; and 6 rolling mills, 1 of which is erecting an open-hearth steel plant.

TABLE III.—Iron and Steel Works of the United States.

	January, 1896.	January, 1894.
Blast furnaces:		
Completed: Bituminous 256		
Anthracite and coke..... 117		
Charcoal 96		
	469	519
Being built	10	..
Capacity, completed, tons	17,373,637	16,271,027
Bituminous	13,118,000	11,679,700
Anthracite	3,156,487	3,305,887
Charcoal	1,098,550	1,285,440
Rolling mills and steel wrks, complt'd	505	487
Being built and rebuilt	5	9
Puddling furnaces (dble. ones count 2)	4,408	4,715
Heating furnaces	3,356	3,054
Rolling mills completed. double turn*	14,763,920	12,477,890
Having cut-nail factories.....	53	55
Cut-nail machines	4,598	5,094
Wire-nail works	53	54
Standard Bessemer steel wks complt'd.	43	43
Standard Bessemer converters	99	95
Bessemer steel works, being built...	..	1
Annual capacity, tons	9,472,350	7,740,900
Clapp-Griffiths steel works, completed	3	4
Converters	5	7
Robert-Bessemer steel works (1 partly built)	3	4
Converters (2 partly built)	5	6
Walrand-Legenisel steel works.....	1	..
Open-hearth steel works, completed..	88	81
Being built	4	1
O.-H. steel furnaces (225 completed,17 being built, 3 partly built).....	225	189
O.-H. steel furnaces (all) capacity....	2,430,450	1,140,000
Crucible steel works, completed	45	48
Being built	..	1
Capacity, tons	98,700	99,000
Steel melting pots at each heat....	3,094	3,103
Tinplate works, completed	69	56
Being built	4	2
Forges making wrt. iron from ore...	9	11
Annual capacity, blooms, billets**..	17,075	17,870
Bloomaries	14	14
Annual capacity, blooms, dble turn	37,650	30,925
Plate and sheet mills completed (incld. rolling mills and steel works).....	156	..
Structural iron and steel works (included as above	40	..
Stamping works, completed..... ..	27	..
Bridge works, iron and steel.... ...	74	..
Shipbuilding works, iron and steel..	36	..
Malleable iron works	82	..
Cast iron and cast steel pipe works..	70	..
Wrt. iron and steel pipe and tube wks	38	..
Car axle works	64	..
Car wheel works	112	..
Car works	112	..
Locomotive works	22	..

*Capacity. **Double turn, gross tons.

ASPHALT LINING FOR WATER-WORKS RESERVOIRS.*

By L. J. Le Conte,** M. Am. Soc. C. E.

Asphalt as a lining for reservoirs has been in use on the Pacific coast for a long time, and its efficiency, durability and economy have been well established. The first attempts made in this direction were confined to patching old, leaky tanks. The experience thus gained was encouraging and led to extending the application to larger tanks and reservoirs. The trouble in regard to the flow of the lining, when exposed to a hot blistering summer sun, then became more pronounced. Many trials and disappointments followed; but improvements followed with experience, until now we may say that the practice of to-day has certainly reached great perfection, although there is yet much room for future improvement. The fundamental principles to bear in mind in all cases whatsoever are as follows:

(1) A reasonably firm foundation to support the lining is necessary; i. e., if the foundation yields too much under water pressure, the lining is likely to be ruptured.

(2) The first coat should be liquid asphalt, so-called, which has great penetrating qualities, enters freely into the foundation soil and takes root, so to speak. This coating has great adhesive qualities which are of great value, but on the other hand it is utterly lacking in ability to stand the sun heat.

(3) The second coat, the sunproof coat, should consist of hard rock asphalt heated up to 300° F. and applied hot. This coating is both waterproof and sunproof, but is utterly lacking in adhesive qualities, and were it not for the first coat underneath could be taken up readily from the floor like a carpet. It is clear then that the first coat is simply a cementing material to hold the outer coat in place.

The foregoing is all that is necesary in ordinary cases, but in special cases where the side walls are vertical additional precautions have to be taken in localities where the sun's heat is intense, as will be seen further on.

The lining generally used in the older reservoirs on the Pacific coast is a poor grade of porous concrete, faced either with a 1-in. layer of high grade sidewalk finish, or else a facing of brick laid with Portland cement mortar. Both these linings are good, provided the foundation material is firm and stable. This is rarely the case in practice. Subsequent settlement often cracks the lining and leakage begins and generally increases rapidly, soon impairing its usefulness. For patching up and repairing such failures, the best lining, beyond all question, is asphalt. It will stand an extraordinary amount of distortion and crumpling, due to settlement of the ground, and yet preserve its water-tight qualities.

One of the hardest cases with which the writer has had to deal was a small reservoir at Mill Valley, Cal. Its location is on the flank of a rugged canyon or ravine. One-half of the base was on solid rock and the other half on made ground. Trouble due to unequal settlement followed its construction. The lining of the old reservoir was 12 ins. of concrete faced with a 1-in. coating of high grade sidewalk finish. That portion over the made ground settled, breaking the lining all to pieces. The cracks were repeatedly dug out and filled with new material of the same character, but to no lasting purpose. The leakage became so great that the water company decided to build a new reservoir and to abandon the old one. The new reservoir was built and the supply transferred to the new pipe line. The old reservoir soon emptied itself and a careful examination followed.

The side slopes were nearly vertical. The larger cracks were in the corners and at the foot of the side walls. It was finally decided to try an elastic lining of asphalt. Extra precautions had to be taken to avoid the crawling down of the steep side slopes. The specifications required: (1) Cleaning out and filling the fissures up full of neat Portland cement paste. (2) Cutting V-shaped grooves in the new joint filling and refilling the grooves with asphalt mastic (20% asphalt and 80% sand) until flush with face of the old lining. (3) The entire inner surface of the reservoir then received a heavy uniform coat of liquid asphalt, as an adherent. (4) The four side walls were then covered with a heavy grade of burlaps such as is used for making grain sacks, anchored at the top and hauled down taut and pressed into the green liquid asphalt. The lower end of the burlaps is made to lap over about 3 ft. on to the bottom beyond the foot of the side-walls. (5) The bottom is then covered with a 2-in. layer of asphalt mastic, put down in two thicknesses, 1-in. each, and well rolled with hot iron rollers. (6) The entire inner surface of the reservoir was then coated with a first-class hard finish composed of rock asphalt heated up to 300° F., and put on hot, forming when completed an impervious waterproof elastic lining which has, so far at least, stood the hottest summer sun without creeping down the walls. The old tank thus repaired has been constantly in use since September, 1894, and no signs of leakage anywhere—and so far as usefulness is concerned, is as good as new. The contract price for the entire work of repairs was at the rate of 16 cts. per sq. ft. of inside facing.

The success attained in relining old leaky reservoirs and the economy and dispatch with which the work can be done, all suggested the propriety of lining new reservoirs with asphalt at once, and doing away with the old-fashioned expensive masonry lining to a large extent. Wherever the natural ground at the site is stiff material, capable of giving natural support to the elastic lining under the water pressure of a full reservoir, the simple asphalt lining alone can be applied with perfect success. Even where artificial banks are necessary, if they are carefully made and well rolled in thin layers to avoid undue settlement, the asphalt lining is preferable and cheaper, notably the two larger 22,000,000-gallon reservoirs at Denver, Colo., where contract price for the lining varied

*Abstract of a paper read at the annual convention of the American Water-Works Association held at Indianapolis, Ind., May 26, 27 and 28.

**Asst. Engr. Oakland Harbor Works, Oakland, Cal.

from 13.3 to 15cts. per sq. ft. of facing, or, roughly speaking, about half the cost of a good first-class concrete lining.

The Linda Vista reservoir in Oakland, Cal., is all in excavation, soil sandy clay and gravelly seams; capacity 5,000,000 gallons, side slopes 1½ to 1. Here the asphalt lining was adopted, and was laid directly on the soil—first, a coating of 1.3 to 2 ins. of asphalt mastic, as before mentioned; and second, an outside hard finish of hard rock asphalt as a sunproof coating. About two years after, during a hot spell, when the water was low, the mastic lining showed some signs of creeping down the slopes. An outside layer of liquid asphalt and burlaps, covered by a hard finish of rock asphalt, completed the repairs and stopped the creeping entirely. It is now four years old, and the entire cost was 15 cts. per sq. ft.

A great deal has been said and written about the troubles experienced at Portland, Ore., reservoirs, in some instances having a tendency to give asphalt lining a black eye. It has taken me some time to collect the following interesting facts relating to these reservoirs. I thought it proper to submit the same to the water-works engineer for correction and amendment such as he saw fit to make. I submit them now as being substantially correct as far as our knowledge goes. It seems to me that the facts below submitted go to show the remarkable utility of asphalt as a lining under the most trying circumstances.

There are four reservoirs in the system. Reservoir No. 1 is situated in East Portland, 400 ft. above low water in the river; capacity, 12,000,000 gallons; location, ravine near top of Mt. Tabor; soil, loam, with sand for first 10 ft., balance cemented gravel; depth, 33 ft.; side slopes, 1½ to 1. The dam is made of concrete, inner face vertical and backed with earth and stone on the downstream side. The lining is 5 ins. of Portland cement concrete strengthened with a net-work of ⅜-in. twisted iron, meshes 18 ins. square, held in place by anchor bolts driven into the slopes at 10-ft. intervals both ways; then a top facing of 1-in. Portland cement plaster sidewalk finish; then an outside coating of hard Alcatraz asphalt (300° F.) put on hot, ⅛-in. thick, with mops and brushes. This concrete lining was partly subdivided by V-shaped joints 3 ins. deep, 1 in. wide at the top and tapering to ½ in. at the bottom. These joints extended down both slopes and across the bottom. The intervals between joints are 10 ft. These joints were made by imbedding wedge-shaped boards in the concrete and pulling them out after setting had taken place. They were painted inside with hot Alcatraz asphalt and then filled flush with asphalt mastic of 80% sand and 20% asphalt, both hot when mixed, and rammed hard. The top coating ½ in. thick of course passes over all. This reservoir has been in use continually and has given no trouble.

Reservoir No. 2 is situated on the flank of Mt. Tabor at an elevation of 220 ft. No dam was necessary. Dimensions, 700 × 250 ft.; depth, 20 ft.; capacity, 20,500,000 gallons; side slopes, 1½ to 1; top soil, 8 ft. loam; middle, 8 ft. yellow clay and boulders; bottom, 8 ft. rotten rock and clay. The easterly half of the elevation was dug down to the original grade. Rock excavation was slow and would probably delay work another season, hence a change in the original grade of the bottom, whereby it was raised 5 ft. higher and compensating for the same by raising the banks 5 ft. This change led to back-filling the easterly or first half of the bottom excavation, thus raising it up 5 ft. to come flush with the new grade adopted. The material used for back-filling was taken from the westerly end and was largely boulders, rotten stone and clay to fill the voids, and a top layer of clay. This whole area of made ground was then rolled with a 15-ton roller and made flush with the rock foundation, extending throughout the westerly half of the bottom.

The lining consists of a layer of sand 2 ins. thick, two courses of hard burned brick dipped in asphalt and laid flat with courses at right angles, and breaking joints. The joint between the courses, like the top face, was well floated with hot asphalt ⅛-in. thick. After completion the reservoir was filled with water, but after eight or ten days it was noticed that there was a leak somewhere. When the water was drawn off it was found that a large portion of that half of the bottom paving over the back filling was distorted and in a few places where it was sharply depressed more than 10 ins. or 12 ins. below grade the lining was broken and leaks created. Elsewhere, although much distorted and unsightly, the lining did not appear broken. All of the west half of the bottom underlaid by solid rock was intact, although there was some settlement in places. The side slopes were entirely free from breaks although the continuity of the faces was marred by numerous depressions which marked the sites of blasts set off by excavators. The holes in the bottom are now filled with good puddle, from time to time, and the leakage is of no importance. The reservoir is in constant use.

Reservoir No. 3 is situated in the City Park, West Portland; dam, concrete; capacity, 16,500,000 gallons; side slopes, 1½ to 1; depth, 49 ft.; ground, stratified clay, the seams next the main hill being wet or springy. After excavation was completed this ground showed some signs of sliding, and a large amount of soil was removed from the hill above the excavation and the side slope re-established. The lining is a 5-in. layer of Portland cement, concrete and twisted iron, with 1-in. concrete sidewalk finish covered with ⅛-in. of hot Alcatraz asphalt. After completion of the reservoir the ground continued to crawl down hill, developing large concentric waves or wrinkles in the bottom paving and horizontal and vertical cracks in the slope lining above. A massive buttress of Portland cement concrete was built at the top of the slide extending half way up the side slope. No leaks were developed in the lining below the top of the buttress although it presented an unsightly appearance. Above the buttress, however, the paving suffered further distortion and many fissures appeared, superinduced by wet weather. The reservoir is now in use, being half full only. The lining is in good order, except at and near the landslides.

Reservoir No. 4 is situated immediately below reservoir No. 3 and in the same ravine. Capacity, 17,700,000 gallons; depth, 40 ft.; side slopes, 1½ to 1; ground, stratified clay, with seams of wet gravel in places. The lining is first an 8-in. layer of good puddle over the entire area, then the same as for reservoir No. 3. The trouble was also caused by a landslide coming down the hill, as in the case of reservoir No. 3, but more pronounced. The reservoir has been used only part of the time.

The success met with so far has naturally led to further effort in the direction of economy. The cost per cubic unit can of course be reduced by admixture of broken stone with the asphalt, precisely as in ordinary cement concrete. The new 40th St. reservoir in Oakland is now being lined with 4-in. asphalt concrete. Depth, 20 ft.; side batter, 2 horizontal to 3 vertical; capacity, 4,000,000 gallons; soil, stiff sandy clay, and seams of sandy gravel. The surface of the ground is first covered with cheesecloth stretched taut and painted with liquid asphalt. The asphalt concrete is then laid on hot behind suitable mold-boards and rammed hard, beginning at the bottom of the slope and working up. In regard to the Portland reservoirs it is proper to state that they are only used for storage purposes, the main supply being distributed through the gate house direct, so that the injury to the reservoir slopes does not at all interfere with the delivery of water or operations of the new supply.

Although the efficiency and economy of asphalt for lining is now well established, nevertheless there are some able engineers who still question its durability. This is a point upon which opinion has little weight—time alone can settle the matter. But it so happens, there now exists on the Santa Barbara coast a natural demonstrative proof of durability which to my mind will outweigh all the opinions of to-day that can be brought against it. I have reference to the asphalt dike or natural breakwater which projects out into the Pacific Ocean some half a mile. This dike formerly filled a fissure in the country rock. The stone on either side has been worn away in past ages by slow erosion and the dike stands out in bold relief, like a quartz ledge.

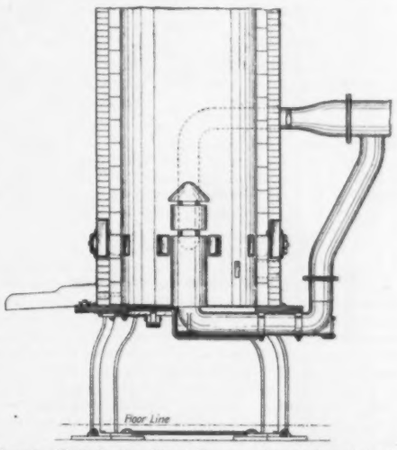
In regard to the strength of asphalt it may be stated that an asphalt brick 2¼ × 4 × 8 ins., laid flat, was subjected to a pressure of 110 tons continued for 24 hours. Its thickness was reduced to 2 ins. without cracking or breaking. As to tensile strength, briquettes made of asphalt break with a strain of 480 lbs. to 490 lbs. per sq. in.

Asphalt concrete as now used shows when broken a natural fracture passing right through the small stone used as an aggregate. This concrete is not only stronger than Portland cement concrete, but also is impervious to water, a quality of inestimable value, and very hard to obtain with ordinary concrete. There is another important feature which I have omitted to mention, the natural solvent pure bitumen used in preparing the materials. This is a practical item of inestimable importance. It is obtained easily in California by taking bituminous sand, placing it in a suitable drain, and turning in hot steam from a boiler near by, using a steam hose and noxzle, etc. As a result the sand settles to the bottom of the hot condensed steam water, the pure bitumen floats on the top, and is skimmed off while the hot water and sand are run to waste on the beach. The solvent more commonly used in the Eastern states is a petroleum residuum, which is objectionable for two reasons: (1) it is soluble in water, and (2) it is not a true solvent, inasmuch as after the mixture is made the asphalt has lost its original character to a certain exteit, and can never regain it. On the contrary, the natural solvent, pure bitumen, is always the best to use for two reasons: (1) it is insoluble in water; (2) it is a true solvent, the two ingredients are not affected by mixture, the asphalt maintaining its original character. Practical men cannot pay too much attention to this point.

A CUPOLA WITH A CENTER BLAST TUYERE.

The accompanying illustration shows the Crandall improved cupola, with the Johnson centre blast tuyere, manufactured by the Foundry Outfitting Co., of Detroit, Mich. The air, instead of being forced into the cupola from tuyeres at the sides only, is also supplied from the inside by means of a center-blast tuyere attached to the under side of the bottom plate. This tuyere terminates about an inch above the top of the outside tuyeres, and a continuous annular opening is formed for the blast by putting on a loose section of pipe and spacing it apart by means of pins that can be varied in height, so as to get any desired opening.

On top of this loose section a cap is set, also spaced apart from it by means of pins, so that a second opening is formed for the blast. Both the loose pipe section and the cap can be removed to have the lining on them repaired. Opposite each outside tuyere is a 6-in. cover filled with mica, to see through the tuyere into cupola, the cover being so large that any coke or other ob-



Cupola With Center Blast Tuyere, Manufactured by The Foundry Outfitting Co., Detroit, Mich.

structions that may fall through the tuyere can be thus easily removed from the air chamber. The upper part of the center blast, between the two annular tuyere openings, and also the top cap, can be lifted off. Both are supplied in duplicate, so that while operating this cupola, one set of these parts can be lined up and dried in the core oven, while the other set is being used. The opening can be changed at will by putting longer or shorter separating pieces in. These latter are pieces of gas piping fitting over short pins.

The claims made for the cupola with center blast are: A saving in brick lining; a saving in fuel; more rapid melting with less volume of blast; and a more uniform temperature of iron than can be obtained by the side tuyeres alone.

Two of these cupolas are in operation at the works of the Howe Scale Co., of Rutland, Vt., and another at Troy, N. Y. One is now being put up at the works of Wm. Bayley & Sons Co., of Milwaukee, Wis., and other orders for complete cupolas have been received.

AN EIGHT-WHEEL EXPRESS LOCOMOTIVE has been built at the Chicago shops of the Chicago, Rock Island & Pacific Ry., to take the place of the ten-wheel engines now in use on the Illinois Division. It was designed by Mr. George F. Wilson, Superintendent of Motive Power, and the boiler was built by the Brooks Locomotive Works, of Dunkirk, N. Y. The coal space of the tender has sloping back and sides. The general dimensions are as follows:

Driving wheels	6 ft. 6 ins.
Driving wheelbase	8 " 6 "
Total wheelbase	23 ft. 1½ ins.
Weight on driving wheels	83,000 lbs.
Weight, total of engine	125,000 "
Weight, engine and tender	203,000 "
Cylinders	19½ × 26 ins.
Boiler, type	Extended wagon top.
" diameter of barrel	5 ft. 1 in.
" rail to center line	8 ft. 5½ ins.
Boiler pressure	190 lbs.
Firebox, radial stay	9 ft. × 2 ft. 8⅞ ins.
Grate area	24.5 sq. ft.
Tubes, number	290
" diameter outside	2 ins.
" length	11 ft. 7 ins.
Heating surface, tubes	1,795.0 sq. ft.
" " firebox	193.3 " "
" " total	1,988.3 " "
Smokestack, cylindrical, diameter	1 ft. 7½ ins.
" height of top from rail	15 " 6 "
Coal capacity of tender	8 tons.
Water capacity of tender	4,000 gallons.

A FAST RUN between Chicago and Rock Island was made on the Chicago, Rock Island & Pacific Ry., June 3, with the new eight-wheel engine described above. The run of 181 miles was made in 219 minutes, including 8 stops which aggregated about 25 minutes. This gives 194 minutes running time, and the highest speed obtained was 70 miles per hour. The train consisted of five cars and weighed about 500,000 lbs.

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The great calamity by which, on May 27, at St. Louis, hundreds of persons were killed, thousands made homeless, and millions of dollars worth of property destroyed, ranks among the great disasters of modern times, and is doubtless the greatest devastation on the whole ever caused by a single tornado in this country. The ruin left by the storm is told in a series of photographs in this issue, which describes more graphically than words can do the magnitude of the forces which did the work of destruction. The extent of this calamity calls renewed attention to tornados, and raises anew the question of what engineers can do to avert destruction from such sources. The frank answer to this question, which every engineer who carefully studies it must give, we believe, is "very little." We do not mean to say by this that great structures, such as the bridges which span the Mississippi, or lofty office-buildings of steel construction, cannot and should not be made so massive as to resist enormous wind forces; but these, after all, cut but a trivial figure in comparison with the ordinary structures—dwellings, shops, mills, bridges, and the like—which cannot, in the nature of things, be made strong enough to resist the force that a tornado may exert.

The fact is that no one knows, nor is there any means of ascertaining what is the greatest pressure which may be exerted in a tornado, nor what is the greatest area over which such a force may be exerted, nor for how long a time such a force may act.

Probably the greatest "feat of strength" on record by a tornado was the lifting of a locomotive in East St. Louis a quarter of a century ago, very close to the spot where the recent storm did such destructive work. If such a force were to be exerted over the whole of a great bridge, for a long enough time to overcome its inertia, who can tell the result? On the other hand, we have good reason to believe that the area of maximum force in tornados is never large, and that the force exerted is of very brief duration. Further, tornados may be of almost any degree of intensity, from a trifling little whirlwind to the terrible whirling pillars which devastate towns and cities. The engineer entrusted with the design of a great structure, who provides against wind pressures equal to those due to the greatest recorded velocities of direct winds, may well believe that it would in all probability resist successfully the force of a tornado, even though he can never be absolutely certain of it.

As we have said above, however, it would be financially impracticable to construct any ordinary buildings of a strength to resist a tornado force; and, fortunately, the chances of a given spot being visited by a tornado are so small as to make such a precaution economically unwise. The path in which a tornado works destruction covers but a small area, "from 50 to 1,000 ft. in breadth and from 5 to 100 miles in length," according to Russell. It appears likely that even in the region where tornados are most common, the chances are that a given spot will be swept by a tornado only once in some hundreds of years. This being the case, it would not pay to add even a small percentage to the cost of any ordinary structure for the sake of making it proof against a tornado's force, even if it were possible to do this.

The horseless carriage fever is having a much more severe run in England than in this country, and public interest in the subject is so great that the promoters of joint stock companies are taking advantage of it. Our contemporary "The Engineer" publishes in its last issue a full-page advertisement of the prospectus of "The Great Horseless Carriage Co., Limited," and we have also received circulars much resembling circus posters in their rhetoric, advertising the company's shares. The concern is capitalized at the gentle figure of £750,000; but it does not appear that it has done any business or acquired any property. It proposes to acquire licenses for working certain patents, on terms not stated, but as the patentees are most of them members of the Board of Directors, the terms are doubtless sufficiently liberal. One member of the Board of this "Great" company is the famous E. J. Pennington, once a resident of Mt. Carmel, Ill., whose flying machines, exhibited in Chicago in 1890-'91, will be remembered by many of our readers. The prospectus of this "Great Horseless Carriage Co." is written in a style so similar to that of the famous "Mt. Carmel Aeronautic Manufacturing Co., Cash Capital, $20,000,000, ready to be paid in," that we suspect Mr. Pennington must have had a hand in the composition of the former.

We have frequently expressed our belief that motor vehicles, as we prefer to call them, are likely to come into extensive use, as soon as their manufacture is taken up in a business way, so that vehicles of good mechanical design, which shall be durable and economical to operate and not too expensive in first cost are placed upon the market. But it does not follow from this that investors in companies organized to build motor-carriages or exploit motor carriage patents do not need to keep their eyes open.

Notwithstanding the fact that the bicycle was introduced in England earlier than in this country its use as a vehicle in daily business and not merely as a pleasant recreation does not appear to be anything like as common in England as in this country. Our contemporary "Engineering" (in an editorial on the operations of the professional company promoter in the new field afforded by the horseless carriage boom, to which we have referred above), says that bicycling is chiefly valued as an athletic pursuit, or at any rate as a means of taking exercise, and it further states that bicycling for women will "go out like a snuff" when fashion changes, as did roller skating. In this country bicycling is becoming more and more a means of cheap and convenient transportation, especially for persons living in suburban districts or the outlying residence districts of a town, who use the bicycle as a carriage to convey them between their offices and residences. In almost any city one cannot but be struck by the morning and evening processions of bicyclists (men and women), riding to and from business. Even the laboring man has been able to avail himself of this means of transportation, and already one of the labor unions has objected to its use, as it enables a journeyman plumber to get around more quickly and consequently do more work in a day than when he has to walk. Bicycles can be, and are, ridden over very bad pavements, but one result of the general adoption of bicycling has been to induce municipal authorities to improve street paving, and to establish long continuous routes of well paved streets especially for cyclers' convenience. Bicycling is not comparable with roller skating, which was merely a recreation of very limited application. A means of transportation like the bicycle, which is of general application for business or pleasure riding, by both sexes, and which is at once the most popular recreation ever devised and one of the greatest of labor-saving tools, is not "likely to go out like a snuff." It is more likely to increase steadily, in this country at any rate.

The ship canal craze which has infected the world for the last dozen years or more has been especially virulent in France; and was largely responsible for the loss by that nation of so many millions in the Panama fiasco. A scheme on which a great deal of enthusiasm and patriotic devotion has been lavished is a canal on French soil, from the Mediterranean to the Bay of Biscay. The agitators of this enterprise attracted so much public attention that the French Government, a few months ago, finally consented to appoint a commission to examine and report upon the enterprise. This report, which has just been rendered, is unanimous in condemning the scheme. The canal would have to be 220 to 320 miles in length, and if made large enough for the French battle ships would cost from $200,000,000 to $300,000,000. The slow speed of navigation in the canal would probably more than neutralize its saving in distance, as compared with the voyage via Gibraltar. There is thus no commercial reason for the canal's construction, and no sensible person could approve the expenditure of even a small fraction of that sum merely on account of its possible value as a naval auxiliary.

Our attention has been called to some possible confusion in our article on the Wilkes Barre filters in our issue of May 21, regarding the relation of Mr. Edmund B. Weston, M. Am. Soc. C. E., to the Wilkes Barre Water Co., for whom the filters were put in, and the Morison-Jewell Filtration Co., who built the plant. Mr. Weston was consulting engineer for the Wilkes Barre Water Co., and not for the Morison-Jewell Filtration Co., as might be inferred from the text, although the contrary was clearly indicated by the inset sheet.

THE EFFICIENCY OF STEAM BOILERS.

The subject of the efficiency of steam boilers has recently become the occasion of considerable controversy among boiler makers and owners and engineers interested in the making of evaporative tests. The controversy having occupied the attention of the members of the American Society of Mechanical Engineers at three successive meetings, and having been the occasion of numerous articles and letters in technical journals, it would appear that the time has arrived for a thorough investigation of the subject. Such an investigation it will no doubt receive by the Boiler Test Committee, appointed a year ago by the above-named society, which has thus far merely reported progress in its work. All sides of the question have now been presented in the papers and discussions before the society, and the subject now appears to be in a shape which makes it possible for us to make a brief review of it for the benefit of such of our readers as have not hitherto followed the discussion.

The beginning of the custom of expressing the performance of a steam boiler by the term "efficiency" is quite recent, but somewhat obscure. Ten years ago the term was scarcely ever heard. At that time, in fact, tests of steam boilers were somewhat rare. In the records of tests of 13 boilers at the Centennial Exhibition in 1876, the term does not appear. The economic performance of the boilers was expressed in terms of pounds of water evaporated from and at 212° F. per pound of coal and per pound of combustible. The record made by five of these boilers, viz.: from 11.8 to 12.0 lbs. of water per pound of combustible was for many years after 1876 accepted as about the best performance possible with any ordinary type of boiler with anthracite coal. When Cum-

FIG. 10.—VIEW AT EAST END OF EADS BRIDGE LOOKING TOWARD EAST ST. LOUIS SHOWING WRECKED CHICAGO & ALTON TRAIN.

FIG. 8.—VIEW AT EAST END OF EADS BRIDGE SHOWING SECTION OF MASONRY APPROACH WHICH WAS WRECKED.
Derailed Rear Cars of Chicago & Alton Train at the Right.

FIG. 12.—LAFAYETTE PARK, IN ST. LOUIS RESIDENCE DISTRICT.

FIG. 11.—VIEW OF WRECKAGE FROM THE SITE OF THE RELAY DEPOT IN EAST ST. LOUIS.

THE ST. LOUIS TORNADO OF MAY 27, 1896.

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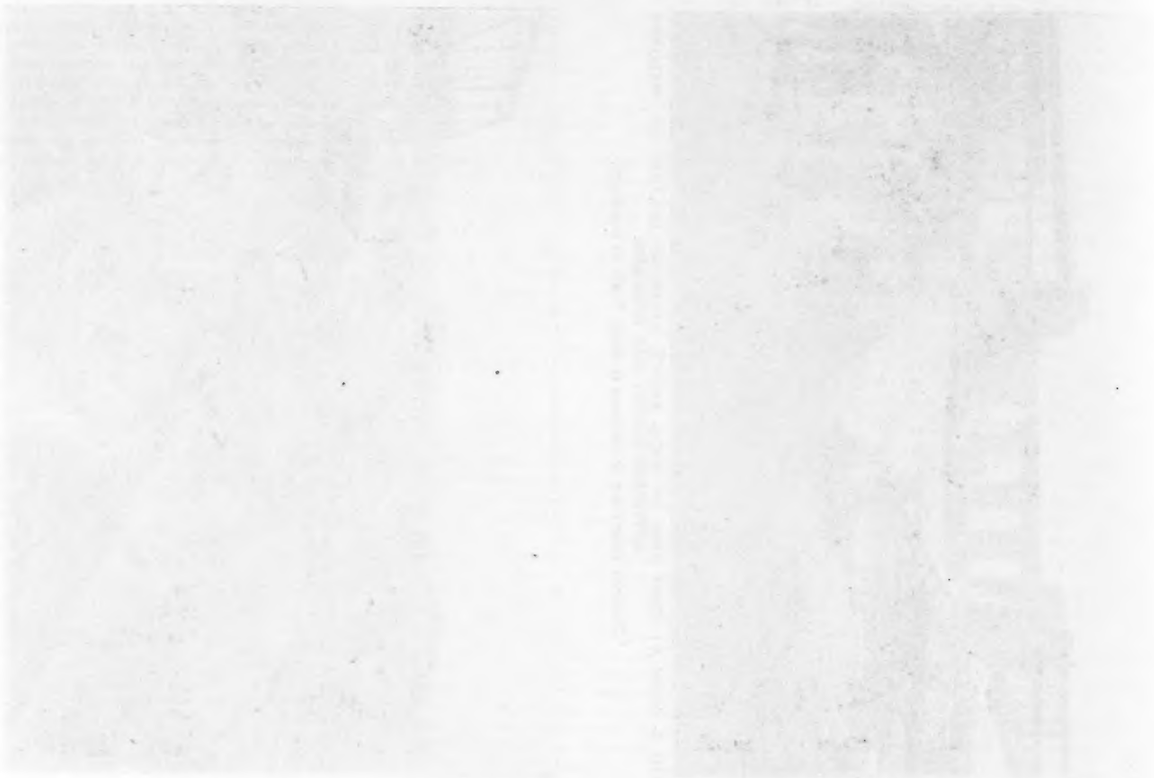


berland, Md., semi-bituminous coal became commonly used for boilers in New England, records between 12 and 12.5 lb. became somewhat common, and similar records were frequently obtained with Clearfield, Pa., and Pocahontas, W. Va., coals. The reason these coals gave better records than anthracite was explained by the chemists to be the fact that these coals contained from 18 to 22% of volatile matter, which was chiefly composed of hydrocarbons, which had a higher heating value than pure carbon. Until about 1882 few commercial tests of boilers had been made west of the Allegheny Mountains. In the vast western section of the country on or near the Ohio and Mississippi Rivers, where coal was very cheap the old style two-flue boiler reigned supreme. A standard size became generally adopted, viz.: about 28 ft. long, 42 in. diameter, with two 14-in. flues. In districts away from the rivers the horizontal tubular boiler became the favorite, and it also attained dimensions which became quite generally adopted, viz.: 16 ft. long, 54 to 66 in. diameter, with from 60 to 90 4-in. tubes. Both styles of boilers were sold according to size, thickness of shell, quality of iron or steel used, kind of front, etc. If specifications were drawn, a boiler of such and such dimensions was called for with the size and thickness of shell, quality of material and workmanship, size of grate surface etc., specified; but a guarantee of economy was never thought of, and tests to prove guarantees were never made. The economy actually obtained in practice in the West was generally atrociously poor. Temperatures of the gases going to the chimney were often from 800 to 1,000° F., and dense clouds of smoke issuing from the chimneys were taken as evidence that the mill or factory owning the boilers was busy and prosperous, rather than as evidence of criminal waste of fuel. "I like to see the tall chimneys smoking" was the sentiment often expressed by a Pittsburger, who realized that the more the chimneys smoked the more iron was being made.

At length, however, the water-tube boiler manufacturers began to invade the West. Their only hope of displacing the old styles of boilers was to prove that the new form was more economical than the old, and the only way to prove it was by making boiler tests. Then began the era of boiler testing in the West.

At first the tests were made with Youghiogheny coal, mined near Pittsburg, and with this coal results were sometimes obtained which approached within about 10% of the best results obtained with anthracite. Youghiogheny coal then for some years became accepted as a sort of standard coal for Western tests.

Some time later the boiler testing custom reached St. Louis, but boiler users objected to having tests made with Youghiogheny coal, which was not regularly used as a steam coal in that market. What they wanted to know was what the boiler would do with Illinois coals. So tests were made with these coals, and instead of maximum records of 12.5, 12.0 and 11.0 lbs. of water from and at 212° F. per pound of combustible, which had been reached by water-tube boilers with Cumberland, anthracite and Youghiogheny coals, respectively, such figures as 7, 8 and occasionally 9 lbs. were all that could be obtained, and the trouble even with these figures was that they could not be duplicated day after day. When these figures were compared with those obtained in the East, it was evident that the water-tube boilers would soon get a bad name. It was claimed that they were not suited for Western coals. But the chemist came to the rescue of the water-tube boiler maker, and showed by analysis that the reason such low figures were obtained with Illinois coals was that the coals were of inferior and of greatly variable quality. They contained much higher and more variable percentages of volatile matter than the semi-bituminous coals, and the volatile matter was not of the same kind. Instead of being composed chiefly of hydrocarbon it was a mixture of hydrocarbon with a large percentage of water chemically combined in the coal. Calculated from the analysis by Dulong's formula the heating value of these coals was only 10,000 to 12,000 B. T. U. as compared with 14,000 to 15,000 B. T. U. for the Eastern coals. It was also found that the heating value of a coal could be obtained in a much easier way than by ultimate analysis, viz.: by burning a small sample in an instrument known as a fuel calorimeter, one style of which had been invented by a Mr. Thompson, of England, and another by Mr. Berthelot, of France. Berthelot's calorimeter was very expensive, and no one but a chemist accustomed to the most delicate manipulations could use it. Thompson's was cheaper, and a boiler testing engineer might easily learn to use it. True its results did not usually agree with those obtained by calculation from ultimate chemical analysis, "but so much the worse for analysis," said the testing engineer.

Having obtained the fuel calorimeter, and by it having determined the heating value of a coal, it was easy to express the results of a boiler test in terms of the ratio of the percentage of the heat utilized by the boiler to the heating value of the coal. One pound of water evaporated from and at 212° is equivalent to the utilization of 966 B. T. U.; 7 lbs. evaporated is $7 \times 966 = 6{,}762$ B. T. U. Suppose the 7 lbs. evaporation is the result of a boiler test. It appears low as compared with the 10 or 11 lbs. obtained by boilers in the East. But if we compare the 6,672 B. T. U. with the heating value of the coal as determined by the Thompson calorimeter it is $6{,}762 \div 10{,}000$ or over 67 per cent. which appears to be a fairly good result, and if 8 lbs. evaporation is obtained, the ratio is over 77 per cent., which is a splendid result, far better than a 10 or 11-lb. record obtained with the Eastern coal

The 7 or 8-lb. evaporation is a poor record to advertise the boiler with, so the boiler seller readily grasps at the "efficiency" record of 67 or 77 per cent., and publishes the record all over the country. Not only the boiler maker but the chemist and the testing engineer hail the advent of the efficiency standard. They have both obtained fuel calorimeters, and when tests are to be made on "efficiency" it brings grist to their mill. The "efficiency" idea grows. Boiler makers begin to talk about it, engineers note it in their specifications, and soon "guarantees" are given on the efficiency basis. The engineers who draw the specifications not being familiar themselves with the actual efficiency that can be obtained with the boilers of different proportions, set with different kinds of furnaces and mechanical stokers, and fired with different kinds of coal, instead of writing in their specifications that contractors must guarantee, say, 65 or 70 per cent. efficiency, write: "the contractor shall state in his bid what efficiency he will guarantee." This sets boiler makers to betting against each other not only as to the price of boilers of certain sizes and proportions, but as to what each competitor will guess at as the efficiency which he will guarantee. Impossible guarantees are given, and when tests show that they fail to be fulfilled, lawsuits follow.

Such it appears to us is the history of the "efficiency fad" which is now raging among certain boiler makers and boiler-testing experts. There is no doubt that the expression of the results of a boiler test in terms of efficiency would be an excellent thing if the heating value of the coal used in a test could be definitely ascertained, but when calorimeters vary in their results, and their tendency is to give a smaller heating value to a coal than the true value, and consequently a higher than a true value to the efficiency, it is easily seen that the efficiency is at present a most uncertain and dangerous standard, and one directly tending to dishonest practices.

In his paper read at the Detroit meeting of the American Society of Mechanical Engineers, Mr. F. W. Dean said:

> Extraordinary, if not impossible, guarantees are made, and evidently only for the purpose of securing contracts and trusting to good fortune to escape a penalty. Such guarantees produce injury to other boiler makers, mislead the consumer, later causing him, when he finds out the impossibility of the guarantee, a great deal of annoyance, if not expense, and are, in fact, immoral.
>
> It is not uncommon to use a particularly rich quality of coal on a boiler trial, and to use the result, which is wonderfully good, in advertising the boiler, and thus to deceive the public.

In the paper presented by Mr. Kent at the St. Louis meeting, of which we give an abstract in this issue, it is clearly shown that fuel calorimeter results are in the present state of our knowledge concerning them extremely unreliable, so that a boiler test gives an efficiency ranging from 73 to 86 per cent.; according to two results obtained from identical samples of the coal used in the test. If the samples had been taken by two parties, instead of the same sample being used, the results might be still more widely different. In view of this uncertainty of calorimetric results, it is evident that, as we have already said, there is a necessity for a thorough investigation of the whole subject of fuel calorimetry, and until such investigation is made, the use of "efficiency" as a standard for boiler tests is to be deprecated.

LETTERS TO THE EDITOR.

Random Notes of a Southern Journey.

Sir: As the papers are full of articles describing the replacing of both of the Niagara suspension bridges with steel arches, it is a relief to find the work well under way towards rebuilding the Roebling suspension bridge at Cincinnati, thus preserving for future generations one of the grandest monuments of American engineering. The new anchorages have been built, enclosing the eye-bars for attaching the new cables, which are being made of the highest grade of steel wire ever manufactured. Plate girder saddle bridges are designed to span the old saddles and carry new cast steel saddles above the old ones, of much the same design as those of the East River bridge. The new cables laid in place are so arranged as not to interfere with the old ones, which will eventually be uncradled so as to increase the roadway to 30 ft. and have a 9 ft. sidewalk on each side. The new floor beams will be spaced 15 ft. apart in place of 5 ft. for the old ones.

The new stiffening trusses, 28 ft. deep, will have a parabolic top chord and Pratt system bracing, and will be erected just outside the old ones, but will not be spliced until the floor is raised to the new level, some 5 ft. higher than at present.

In the report of John A. Roebling, in 1867, on the completion of the bridge, he deplored the fact that the bridge had to be located midway between Vine and Walnut Sts., in place of connecting Vine St. in Cincinnati with Scott St. in Covington, thus making one of the finest avenues in America.

The company now proposes to remedy this, in a measure, and have purchased a right-of-way through the block, to Second St., in Cincinnati, and will have an approach viaduct 525 ft. long, giving a much better landing.

Another old landmark is being removed by the rebuilding of the Pennsylvania bridge; the new bridge will be a modern long span, steel structure.

One of the first Melan concrete bridges to be built in this country was recently completed in Eden Park, Cincinnati, and while a handsome structure, shows evidence of the evils of contract work. The main arch is well built, but the ornamental balustrade is badly checked and the filling was hurriedly done, so as to cause a sinking of the roadway pavement.

Many handsome pieces of paving are to be seen about Cincinnati, one of the best being the platforms in the Central Union depot, the work of S. J. Osborne, Jr., & Co. The cement curbs on either side are connected by a cement arch or bridging, left just enough lower than the curbs to admit of the asphalt paving surface.

Going south on the Florida Special, of the Queen & Crescent, is made more delightful by the elegant observation car at the rear of the train. Crossing the Ohio on the old Linville bridge, with its still famous truss span of 515 ft., new approach spans were seen, of heavy riveted lattice construction, while at other points new bridges of modern design were being erected.

This road is noted for its tunnels and bridges. High Bridge, over the Kentucky River, is certainly a great monument to its designer, the late C. Shaler Smith, as are the old suspension bridge towers to Gen. Leslie Combs; a tablet in the stone work recording that he "erected these towers at his own expense." As the train dashes past the towers out on the bridge, one can realize what 275 ft. in the air means, this being the distance to the water.

The other high structures over the Cumberland and over New River are also worthy of note as daring works at the time they were constructed. The stone piers of the Cumberland bridge are being cased in cement to preserve them and will have the appearance of solid concrete work.

In painting the iron work on the line, some years ago, red paint was used and in repainting them a blue shade was being put on so as to insure every part being covered.

The roadbed is finely ballasted with stone and automatic block signals of two different kinds are in use over the entire line.

At Harriman, where the Southern Ry. connects, is one of the many examples of the "Southern boom town." Miles of streets were laid out and macadamized, whole blocks of fine business buildings were erected, several hotels were built and dozens of fine residences. The only warrant to be seen for all this expenditure was two rolling mills, one already beginning to decay and the other in seemingly good repair, but neither in operation.

The Knoxville & Ohio Ry., from Jellico to Knoxville, is

one of the best paying coal roads in the United States, and is operated by the Southern Ry.

The most ambitious railway project in this section is the Ohio River, Knoxville & Tidewater Ry., surveyed from Jellico to Knoxville, with very light grades and a minimum of curvature and projected to reach tidewater on the Atlantic. The projector is Col. Albert Boone, who built the Zanesville & Ohio Ry., down the Muskingum, between Zanesville and Marietta, Ohio. As an auxiliary is the Knoxville Belt Ry., connecting the lines around the city. The completion of the line at an early date is now a necessity, as the recent sale of the Cumberland Gap road has shut out competition.

The Marietta & North Georgia Ry. has just been sold and passed out of the receiver's hands; active steps are being taken to put the road in first class shape.

The greatest need for a railway in Tennessee is for a direct line between Knoxville and Nashville, and the new Tennessee Central is projected to run from Knoxville to a connection with the Nashville & Knoxville Ry. The grading is practically completed, but the hard times has thrown the corporation into the hands of a receiver. Receiver Godfrey has infused new life into the enterprise and local papers report the arrangements to be made for the purchase of rails and equipment.

The city of Knoxville impresses a person as one of the best built cities in the country. It has one of the largest wholesale trades of any Southern city and consequently on the principal streets are seen many fine business buildings. The streets are many of them elegantly paved with brick and have electric car service in all directions.

Manufactures are being developed, there being a large cotton mill, woolen mill, and a rolling mill which turns out neary all the bar iron for local use. The great shops of the Southern Ry. are perhaps the best in the South.

The great industries, however, are the marble quarries and mills, which supply marble for every section of the country.

The principal concerns are the Tennessee Producers' Co., in which Senator Proctor, of Vermont, is largely interested and the Evans Marble Co.

At the former works the huge blocks of marble were seen just from the quarries, of many colors and qualities.

The works contain 24 gang saws, all in operation, cutting out slabs for Park Bros. building in Pittsburg, and for buildings in St. Louis, Boston and San Francisco.

Facilities are also provided for finishing or polishing; but little of this was being done as most of the marble finds ready sale in sawn slabs and some monument work.

The sawing is all done with drag saws of iron, as steel does not work satisfactorily. Diamond cutters have been tried and disused, and it is strange that there has never been any great improvement made in stone sawing.

The Tennessee River is navigable for some distance above Knoxville for boats of light draft, of from 18 ins. to 24 ins. The new steamer "City of Knoxville" has just made a successful trial trip up to Danbridge and is quite a step forward.

Careful surveys have been made of the river by the U. S. Engineer Corps and the work will eventually be carried out of improving the upper river as an extension of the very successful work about Chattanooga.

A trip over the Southern Ry. to Chattanooga shows this company to be making extensive improvements, and the old rails, set in chairs at the joints, together with many other relics of war times are practically a thing of the past.

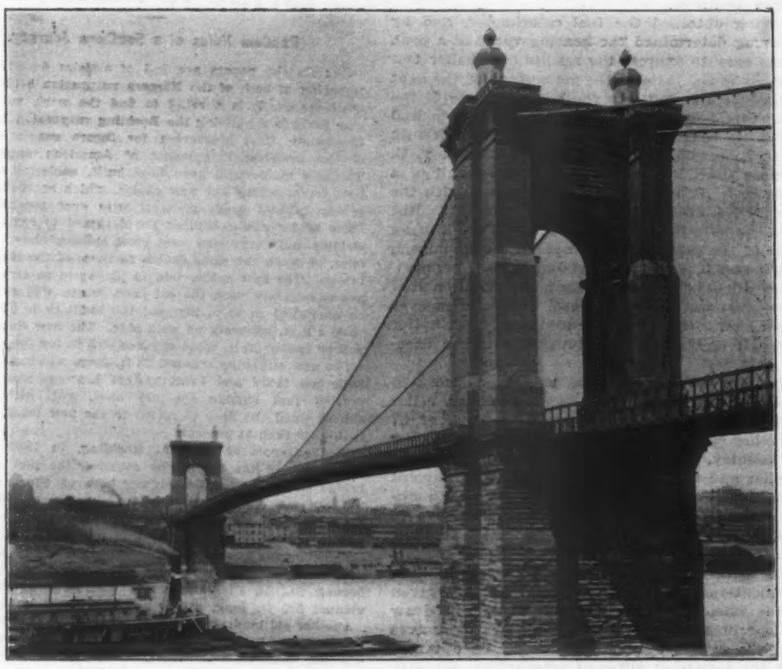
The new incline up Lookout Mountain, which overcomes an elevation of 1,700 ft., is well constructed; having a single track half way up and a three rail track on the upper half. There are two cables to each car, one being a safety cable. Should a car become detached, a large grip engages a guard timber between the rails; the timber being securely dapped and bolted to the ties. The grade at the top, climbing the cliff, is so steep that it was a relief to leave the car.

The Chickamaugua Military Park has given to much of the country southeast of Chattanooga the most elegant macadamized roads, the government having built them as a part of the scheme for a park. Along the roads are placed hundreds of cast-iron tablets with raised letters describing the events occurring at the different points during the terrible battle of Sept. 19 and 20, 1863. Along the lines of battle are monuments erected to the regiments that participated and many of them are of interest from an engineering view, as well as historic.

The system of roads has been extended in a boulevard along the crest of Missionary Ridge, which gives a grand view of the surrounding country and from which could be seen a number of blast furnaces in operation, reminding one that an era of prosperity has begun for this great section, which is destined to become a real industrial competitor of the North.

E. G. C.

May 26, 1896.



THE ROEBLING SUSPENSION BRIDGE OVER THE OHIO RIVER AT CINCINNATI.

URBAN GROWTH AND THE ELECTRIC RAILWAY.

By Louis Bell, Ph. D.

The revolution that has driven the horse out of the street railway business is now an accomplished fact. Boston affords, perhaps, the fairest example, since here the change is quite complete and in large measure took place long enough ago to permit of fairly accurate conclusions. On the other hand, the situation, with a cramped business center and plenty of railway crossings, drawbridges and other obstacles, is not unduly favorable, while the competition from suburban steam trains is at least up to the average.

What, then, has been the effect of the introduction of electric traction on the available area, values and living conditions in and about Boston? To the great mass of humanity it makes no small difference to gain a quarter of an hour morning and evening in going to and from the city, to go for one fare where formerly two were charged, or to find a new home as easy of access as the old one at a few dollars less per month. Thus the increase of the area available for residence in a given time or for a single fare is a matter of great civic importance. The facts with respect to this increase are easily found and are set forth in the annexed map.

This shows Boston and the surrounding region for an average radius of somewhat over five miles from the business center. On it are plotted four irregular curves, marking out four oddly shaped areas. The inner one of these, bounded by a heavy dashed line, shows the limits of a 15-minute ride in the horse cars in 1888, starting from the middle of things as business goes.

A time radius is taken, since, at least within the region of uniform fare, time is the consideration that limits the possible region within which one can live and yet work in the city.

The 15-minute line includes essentially old Boston (except a small part of the South End), a morsel of South Boston just across the drawbridges, a narrow, dingy strip of Cambridgeport, the southernmost corner of Charlestown, and, across the North Ferry at 2 cts. extra fare, a liberal slice of East Boston. It comprises an area of 3.1 square miles, of which nearly one-third is taken up by business blocks, the Common and Public Garden and the Back Bay district, these being excluded from the effective residence district so far as those who work long hours are concerned. The greatest distance of any part of this area from the center of the city is two miles, and the least distance barely over one mile.

Going south along Washington St., the 15-minute line is reached just beyond the one-mile circle, telling as plainly as possible the story of tedious blockades in the great shopping district, where many car lines were concentrated in three narrow streets. Westward, however, the area expands almost to the two-mile limit, in the region of wide avenues and the residence streets of the Back Bay. Just across the Charles, the extreme limit is reached, thanks to the long Cambridge Bridge, far enough up stream to keep the draw from being troublesome. The northern Cambridge Bridge, however, is a very different matter, for its inner terminus is reached only through streets often obstructed by teaming and the draw is often used, so that schedule time must needs be slow. Thus the 15-minute line dips in until it almost touches the one-mile circle at this point. Charlestown is but little better off and for the same reason, but across in East Boston where the streets are fairly clear, a good wide area is taken in. The 15 minutes here includes the ferry, which is not liable to constant interruptions, as is a drawbridge.

Just beyond the area we have been discussing lies a heavy solid line bounding a narrow strip of additional territory, for the most part less than a quarter of a mile in width. This line is the present 15-minutes limit of the electrics. It is closely parallel to the horse car limit, and the small gain of the electrics is at first sight somewhat extraordinary.

But in seven years the increase in the total number of cars that must be forced into the center of the city has been very great, and the bridges are as much of a nuisance as ever. It was evident before that the main delays were in getting fairly out of the city beyond the region of blockades. So long as the running time is limited by the possibility of working through crowded streets the change in motive power makes little difference in the time table, for even the horse cars were compelled to creep. Only in East Boston, where the cars start at the ferry, is a material gain manifest. Here the electrics have doubled the previous speed and the previous area.

In spite of the small increase in speed by the introduction of electrics, the gain in available residence area accessible in 15 minutes is not altogether insignificant. The strip we are discussing amounts to 1.15 square miles, and the total of the previous district has been increased by 37%, or by fully one-half of its practical amount.

The speed of the horse cars for the first 15 minutes was at the rate of nearly 5¾ miles per hour, while the present electrics do a shade less than six miles per hour in the same time of run. At only two points has the gain in speed been noticeable—in East Boston and in the run along the edge of the South Bay toward Dorchester.

Far different are the results when we take up the country beyond, all that which lies within half an hour's run, or about 45 minutes from home to business.

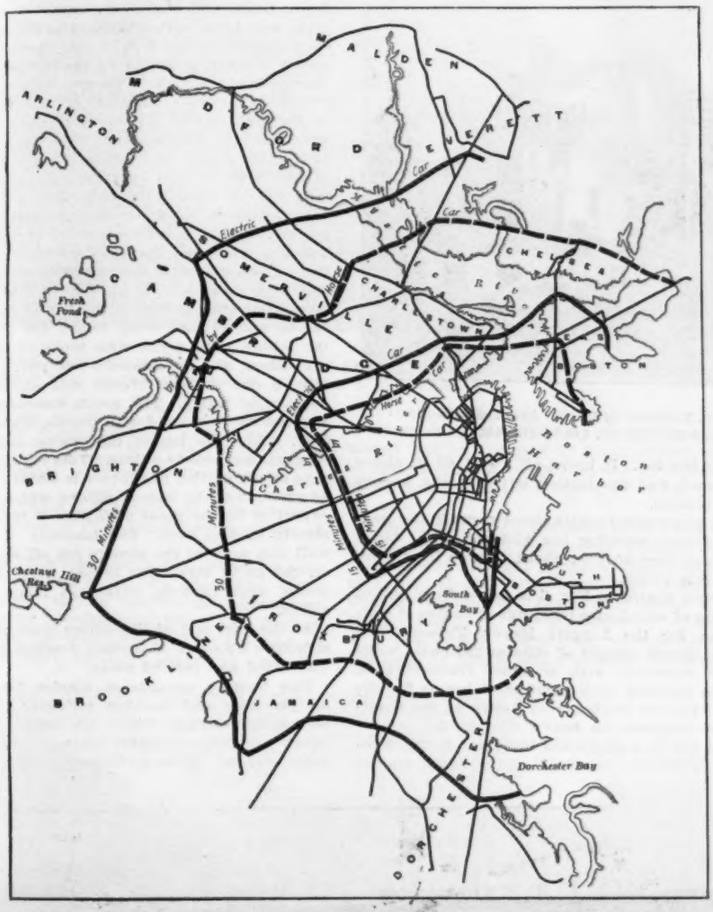
The outer dashed line shows this time limit for the horse cars in 1888. It bounds an area of 14.6 square miles exclusive of water and includes almost the whole of East Boston, Chelsea, and Charlestown, a liberal amount of Somerville and Cambridge, part of Brookline and most of Roxbury. Perhaps the most striking thing about this area is its very great regularity if width beyond the 15-minute line. It is quite obvious that the cars were free to run at their best working speed when once they had escaped from the impeding conditions encountered in the city proper. The schedule time during the second quarter hour averaged almost exactly at the rate of 6⅝ miles per hour.

The half-hour area had a mean radius of a trifle over three miles in 1888. Beyond this the street car service was comparatively infrequent and the suburban population showed a tendency to mass itself along the lines of steam railway, leaving great intervening gaps quite unsettled. So much for the regime of horse cars.

The outermost solid line on the map gives the present half-hour limit on the electric cars. There is here a great change for the better, and the superior speed of

the electrics begins to tell effectively. The actual added area is 8.3 square miles, all of it valuable territory, an increase of 57% over the space previously available in the same time.

The character and shape of the half-hour limit for electrics is of no little significance. It takes in considerable sections of Dorchester and Roxbury, a still larger portion of Brookline, nearly half of Brighton, a narrow strip of Cambridge and no small part of Somerville. It stretches across the Mystic so as to give easy access to Everett and then is ended somewhat abruptly, since nearly all of Chelsea and all of East Boston was included in the half-hour limit even for horse cars and the districts beyond are somewhat inaccessible even now, except by the steam roads.



MAP OF BOSTON AND ITS SUBURBS, SHOWING THE AREA WITHIN 15 MINUTES AND 30 MINUTES OF THE BUSINESS DISTRICT BY HORSE CARS AND BY ELECTRIC CARS.

The average speed of the electrics for the second 15 minutes of their run shows decided improvement. It is very near to 9½ miles per hour, rising to a maximum of about 12½ miles on the line to Chestnut Hill reservoir. The minimum gain in speed is found in Cambridge where the schedule time drops to less than seven miles per hour. This is due to no unusual physical conditions, but to the short-sightedness of the city fathers in that worthy old town, who have prescribed by law a maximum speed of eight miles per hour for all street cars.

Across the Somerville line quite other conditions prevail, and there has been a great gain of useful territory. The speed of the electrics is above the average amount, and growth is unrestricted.

On the Winter Hill line particularly is the speed well maintained, since it has the advantage of running through a strip of park, which is always a material advantage. Nowhere is this better shown than in the quick time made on the Reservoir line, running as it does through the Back Bay park system. Every bit of unobstructed space thus gained is of direct value to the community.

The effect of the electric service on the growth of Boston and its environs is not altogether easy to estimate. The natural effect of improved conditions of transit is to produce a shifting of the population into what one might call the lines of least resistance. This would result in an efflux toward the most available suburbs, so that these would tend to grow at the expense of the city proper. Boston shows an increase of 26.50% in the last decade, a less percentage of growth than any of the surrounding towns and cities, except Chelsea, in which the transit conditions have been almost unchanged in point of time. And this in spite of the fact that Boston includes really suburban regions like Roxbury, Dorchester and Brighton. While the absolute increase in Boston has been 103,000, that merely in the suburbs shown on the map has been more than 80,000, although their aggregate population is little over two-fifths that of the city proper. The increase in Cambridge in a decade has been 36% against 74 for Somerville, 75 for Brookline, 218 for Everett, 81 for Malden, and 60 even for Medford, far past the half hour limit though it is. Great stretches of vacant lots and unoccupied land in the western part of Cambridge bear mute but effective witness to the foresight of those who devised the eight-mile law, while two-thirds of the growth of Somerville has been in the western half.

Marked local growth, due directly to better street car facilities, can be distinctly traced in parts of Dorchester, Jamaica Plain and Brookline.

As regards values, relative and absolute, exact data are not easy to obtain and lack significance in many instances when secured.

The life history of a street is very curious. It begins as a row of surveyor's stakes, and passes slowly through successive stages of residence until it reaches the zenith of its career in solid blocks of broad mansions. Then the insidious dentist arrives, and finally the evil day comes when "Jolie Modiste," appears on a big brass door-plate. That is the beginning of the end; the mansions turn to boarding houses, the butcher, the baker and the candlestick maker open their respective places of business, and in due time our street degenerates into a thing of old clothes, bargain shops and "loan offices." Or, with better fortune, business still marches through it, and it becomes an alley of office buildings and tall warehouses.

Meanwhile the values undergo a like evolution. They increase rapidly for awhile, then more and more slowly, and finally they may even decrease. Now the effect of rapid transit is in general that of a stimulant driving the street more rapidly through its successive stages. When streets are young the effect is to hasten their growth; when they are old it may be to speed their decadence.

It is of interest to inquire into the circumstances under which it is possible for a change of motive power to lower the relative or absolute value of property. At first sight it is not altogether obvious how increased accessibility can depreciate property, either relatively or absolutely, yet sometimes it may be so. Take for example a suburban region at or near the limit of convenient access by the horse cars. Under favorable circumstances it is likely to develop into a fine residence region, since it is most available to those whose hours of business are short or to those who keep carriages and can thus depend on somewhat unhandy steam service. The man who carries the dinner pail has to make his home nearer the city, where his long day will not be further lengthened by a protracted car ride. His home will, therefore, be found in the flats and tenements that skirt the city more closely.

Now comes the electric car and pushes the half-hour limit out a mile or two further. Gradually, but surely, working out across the dismal fringe that forms the backyard of most cities, the man with the dinner pail, who appreciates a good situation as much as anybody, invades the new territory, and just so surely the man with the check book edges away toward regions less painfully accessible. In theory, we are a democratic people; in practice, as far from it as our means will permit.

The process just described has gone on to a limited extent in certain parts of Brookline. It would probably be hard to find a case of absolute depreciation in value, but here and there one could come very near it, while, relatively speaking, some localities have obviously suffered considerably.

Incidentally such an outward migration of population must have the effect of lessening the demand for accommodations in the belt from which the migration takes place, unless the growth of population keeps pace with the increase of available living room, which it has not done in the case of Boston, as has previously been shown. Hence, until the inner area feels the effect of increasing demand for business purposes, it is likely to be at a disadvantage, temporary, it is true, but still existing. There may be, therefore, here and there, traces of a decadent zone inside a zone of growth. In most cases it is not conspicuous and it eventually works out its own salvation.

There sometimes exist, however, fairly good residence areas which have managed to preserve something of their social integrity in spite of the inroads of cheap flats and tenements in their immediate neighborhood, perhaps on parallel streets. To such districts the coming of rapid transit may be the last straw. The surroundings deteriorate in response to the emigration outwards, and the last state of that street is worse than the first. Monument Square, Charlestown, is a striking case in point. Forty years ago there could scarcely have been a residence section with brighter prospects. To-day, save for the homes of a few old and conservative families, it is a forlorn wreck of its former self, unhonored and depreciated. It was quite too accessible, and the humble horse cars had compassed its downfall before electrics were thought of. There are other localities, less conspicuous, in which the same causes have accomplished similar results. Thence come, often enough, wails over the disaster brought by the deadly trolley. The trolley is not at fault; it has simply hastened a little the progress of a perfectly natural urban evolution against which no protests can avail.

One more thing must not be forgotten in looking over our map—the enormous total saving in time—the time available for human industry or recreation. Utilized for work or not, this time saved to the people has a human value for some good not incommensurate with its money value. Every change that lifts the burden of labor for even a few minutes per day is a gain on the whole for civilization, and the reclaiming of waste time is of social importance far greater than reclaiming waste land in that it deals more directly with all people in all places.—"The Street Railway Journal."

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Assessment for Sewer.

No properties can be assessed for a sewer, except those that abut on the line of it; and therefore properties on a branch sewer can be assessed for no part of the cost of the main sewer into which it empties, nor can they be assessed on the average cost of the several branches in the sewer district.—Witman v. City of Reading (Supr. Ct., Pa.), 32 Atl. Rep. 576.

Right to Damages for Elevated Railway.

Where property was substantially vacant, and soon after the construction of an elevated road it was compactly built up, and the fee and rental values increased in consequence, damages to the property abutting on the street upon which the road is constructed cannot be awarded, notwithstanding expert's opinions estimate damages, and though property on side streets has had a proportionately greater increase in value. In every case where a vacant area is built up, and gains an increase in value coincident with the coming of the road, and obviously stimulated by it, the appreciation of property in the side streets is largely due to the same cause, and the case is one in which benefits only have accrued, and they do not become injuries on the avenue because they help more largely the residence lots near by. The railway in the vacant locality cannot be said to hinder what it in fact produces.—Bookman v. N. Y. El. R. Co. (Ct. of App. of N. Y.), 41 N. E. Rep. 707.

THE EFFECTS OF THE ST. LOUIS TORNADO.

By Julius Baier, Assoc. M. Am. Soc. C. E.

(With inset.)

The effects of the tornado which caused such heavy loss of life and property in St. Louis, on May 27, are of peculiar interest to the engineer, owing to the numerous and varied examples presented of the destructive power of the wind. The action of strong, direct winds is well known and generally provided for in good construction.

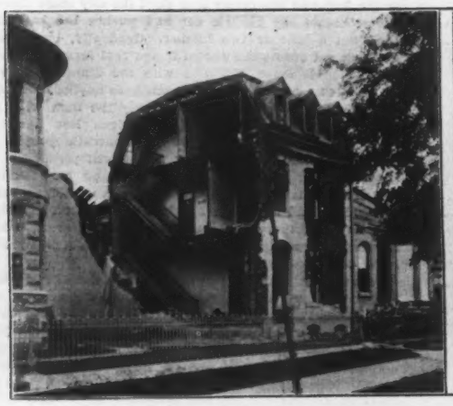


Fig. 1.—House on Park Ave., Opposite Lafayette Park.

Fig. 2.—House at Russell Ave. and Ohio St.

EXAMPLES OF INJURIES TO WELL-BUILT RESIDENCES BY THE ST. LOUIS TORNADO.

Tornados, while of frequent occurrence, have hitherto, with few exceptions, never chanced to pass through large and closely built cities, and little attention has been given to their possible effects under such conditions. The present instance affords us ample opportunity to study their characteristics.

An examination of the district affected by the disaster shows that a large percentage of the destruction was caused by the "explosion" of parts of buildings due to the sudden relief of atmospheric pressure on the outside. The barometric records at the signal service station, located about a mile from the path of the storm center, show, during the passage of the tornado, rapid fluctuations within a range of 0.1 in. and at one time a sudden drop of 0.3 in. followed by a rise of 0.4 in. The variations of pressure in the path of the tornado, judged by the results in evidence on all sides, must have been sudden and intense to an extreme. Where walls are destroyed they have nearly always fallen outward, and this fact only can account for the comparatively small loss of life when the great extent of the damage is taken into account. Most houses have lost all or parts of the roof and top stories. This general tendency to lift the roof is also shown by numerous cases where part of it must have been raised sufficiently to equalize the air pressure and dropped back again. Many curious instances are seen where clothing, boxes and lighter articles have been caught while escaping through the opening with the sudden outward rush of air.

The examples shown in Figs. 1 and 2 will convey better than any description the characteristic features of the ruins in a large district of handsome residences. In Fig. 1 the entire side wall has fallen out, leaving stairs, partitions and roof in good condition. On the front of the house the backing brick are intact, but the face bricks have been forced out by the expansion of the air in the space commonly found in walls of buildings between facing and backing. This want of bonding in the walls of the ordinary houses is clearly shown in many similar cases. In Fig. 2 the wall has been blown out, the partition has been forced forward by air in next room, the ceiling has been forced upwards and was caught and held by the partition before it could fall back.

The district which was devastated by the tornado consisted mainly of residences and small stores. The only larger structures were an occasional factory or manufacturing plant and some large churches.

Fig. 3 shows the power house of the People's R. R. This was a substantial building, and was partly wrecked. The machinery was found uninjured after the wreckage was cleared away and is at present in operation in the open air.

The power house and car sheds of the Scullin Electric railway lines are shown in Fig. 4 after most of the debris had been cleared away. A great part of the damage was caused by the brick chimney which was thrown over and crushed the building. This stack was a very substantial brick structure with double walls, standing 165 ft. above the ground, 18 ft. diameter at the base and 10 ft. 6 ins. at the top. It broke off about 40 ft. above the ground, and the section left standing is seen in the picture.

Fig. 5 is a characteristic street scene in the path of the storm, showing the violence with which street cars were thrown about. Three lives were lost in this wreck.

The view shown in Fig. 6 is taken from one of the group of warehouse buildings in course of construction for the Liggett Meyer Tobacco Co. These buildings consist of substantial outer walls of brick masonry, with an inner framework of cast-iron columns with rolled steel beams for the floors. The iron work is very heavy as the buildings are designed for heavy floor loads.

To the left is a completed building; in the foreground is shown the wreck of the metal framework for one of these buildings which was a duplicate, before the storm, of that shown standing behind it. Three of these buildings were standing in line with inner framework completed, but outer walls only one-story high. The whirl caught the two end buildings without touching the center one, apparently, as loose planks lying on top of it remained unmoved. The framework did not turn over bodily but simply collapsed, the wreck falling almost entirely within the walls. This accident is a forcible illustration of the weakness of cast-iron column construction against lateral forces, due to lack of strong and rigid connections at the joints. The surface acted on by the wind was only that of the framework itself.

The views of the Eads bridge show clearly the damage sustained by that structure. At each end of this bridge is a masonry approach, about 200 ft. long, built of five arches of 27 ft. span, which carries the railway tracks. The floor of the upper roadway is supported over the railway by girders resting on side walls of masonry supported by the main arches. These side walls are 2 ft. 6 ins. thick, and pierced by arched openings 6 ft. wide and 10 ft. 6 ins. high. The pillars between these openings are 2 ft. 6 ins. sq. All this masonry is built of blocks of sandstone of the full thickness of the wall. The west arcade, shown in Fig. 7, is an exact duplicate of that which stood at the east end before the storm, and shows the construction. The girders of the upper roadway are centered over the pillars, have a clear span of about 40 ft. and carry a floor consisting of 6-in. × 14-in. wooden stringers, 3-in. planking and 4½-in. wooden block paving. As seen on Fig. 8, on the inset sheet, it is this entire section of flooring and side walls that was wrecked by the tornado. The masonry side walls broke off on the end arches, as shown in Fig. 9. The structure was lifted and carried to the south; some of the beams and planks being found 400 ft. south of the bridge. The north wall broke at the base of the pillars, and the masonry and part of the floor fell on the railway tracks and obstructed the passage of trains. The south wall broke or was sheared off on a level with tracks, which is about 3 ft. below the top of the coping course which supports the arcade pillars. This fact is worthy of note as the section of rupture is about three times as great as at the base of pillars, which one would expect to be the point of failure if the wall were merely pushed over. The masonry of the south wall and some of the girders fell off the structure on the south side. The tracks were cleared and trains were running within 24 hours after the storm.

At the east end of the center span of the main structure a section of wooden flooring, 150 ft. long, was lifted and carried away.

This flooring consists of wooden block paving on planking and wooden stringers. The latter rest on iron girders which are supported and secured to lattice uprights rising from the main arches below. These girders form the cross struts for the wind truss which extends immediately underneath the upper roadway, from pier to pier. All the iron work of the wind truss, however, was uninjured.

FIG. 7.—VIEW OF WEST ARCADE OF EADS BRIDGE.
(The East Arcade was Exactly Like This Before the Storm.)

It may be worth while to note that on March 8, 1871, while the east abutment of the Eads bridge was in process of construction this same vicinity was visited by a violent tornado. To quote from "A History of the St. Louis Bridge," by Prof. C. M. Woodward:

It came from the southwest across the city of St. Louis doing but little damage, but it struck the east bank of the river with great violence, and for about one-half mile wrought most fearful havoc. In an instant the frames of derricks, travelers, etc., of the east abutment were levelled with the water in one confused and shapeless mass.

* * *

The lesson of the tornado was not lost upon the engineer of the bridge. The original design contemplated an upper roadway wholly of wood, the substructure of which was designed to act as a truss to resist the action of hurricanes upon this part of the bridge. The possibility of a tornado like that just described striking the bridge itself, led to the adoption of an iron wind truss of great strength and stiffness, extending from pier to pier. It is believed that as constructed the bridge is abundantly strong to withstand a tornado as furious as that of March, 1871.

The test to which it has been put 25 years later certainly testifies to the wisdom and prudence of the engineer.

The bridge structure proper has suffered no injury. The masonry of all the piers and abutments is intact, and as regards the superstructure, the writer learned from Mr. U. W. Eayres, Superintendent of Structure, that he has had all of the metal work carefully examined since the storm and found no evidence that it has sustained any injury.

The damage done to the bridge was confined to secondary parts of the structure, and though it is of engineering interest when properly interpreted, it is not of such importance as was given to it by the press in the first reports. The fact that "huge stones were thrown down from the Eads bridge" has created in the popular mind a measure for the violence of the storm out of all proportion to what is justified by the facts.

A Chicago & Alton train was going east on the north track at the time the tornado struck the bridge. All the windows were blown in and the train was partly derailed on the trestle approach just after it cleared the arcade. The last two coaches were overturned toward the south; the other coaches and the engine kept the track. The overturned coaches can be seen in Figs. 8 and 10, taken next morning just as they were being righted.

In the railroad yards many cars were lifted and overturned by the wind. Some of the papers reported the overturning of locomotives, but the writer has failed to find authentic information of such action of the storm after much effort to do so.

Figs. 11 and 12, on the inset sheet, show scenes which picture the destruction wrought by the storm more forcibly, perhaps, than any others that are shown. The buildings which were wrecked in East St. Louis were many of them frame structures, the materials of which were of course widely distributed by the wind, and the mass of debris resulting shows more graphically than any description could do the complete destruction effected over a wide area on the east side of the river.

The view of Lafayette Park will especially interest those who read Prof. Johnson's description of the damage done there in the last issue of Engineering News.

FIG. 3.—POWER HOUSE OF PEOPLE'S R. R. AT 18TH ST. AND PARK AVE.
(Debris Cleared Away So That Cable Driving Machinery is in Operation.)

FIG. 5.—ELECTRIC CARS OVERTURNED IN THE STREET.
(Three Persons Killed in the Wreck.)

FIG. 6. WRECKED FRAMEWORK OF LIGGETT & MEYERS TOBACCO WAREHOUSE.
(The Wrecked Structure was a Duplicate of the One Seen in the Background.)

FIG. 9.—VIEW FROM ROADWAY OF EADS BRIDGE AT EAST TOWER SHOWING FALLEN MASONRY OF ARCADE.
The Debris Which Covered the Railway Track on the Left Has Been Cleared Away.)

CAR PLATFORM GATES are being widely adopted by the Southern Pacific Ry., so as to prevent persons without tickets from getting on trains at stations. Men attend to the gates and require every person to show his ticket before getting on the train.

INFLUENCE OF COKE-OVEN CONSTRUCTION ON THE QUALITY OF COKE.

A paper was read recently at a meeting of the Engineers' Society of Western Pennsylvania, by Mr. R. M. Atwater, on "The Effect of Coke-Oven Construction on Coke,"* in which it was shown that the most important result which is to be expected from the substitution of the retort coke ovens for the beehive ovens hitherto in almost universal use in this country is not the saving of the gas and by-products of the Connellsville and other coking coals, but the use of the coke oven to make good coke from coals which do not make good coke in the beehive oven. This result will enormously increase the amount of the coal which is available for coking in the United States. The Pittsburg coal region is 2,500 square miles in area, and is estimated by Prof. Leslie to contain five billions of tons of coal available for market in the future. Only 2% of the Pittsburg coal is contained in the Connellsville seam, and only half of the latter is standard high grade coking coal.

The available coal left in the Connellsville field is estimated at about 70,000,000 tons, which, at the rate of coke production in 1895, will last only ten or twelve years. The importance, therefore, of obtaining a coke oven which will utilize what are ordinarily considered non-coking coals is apparent. A comparison of the action of the retort and the beehive ovens is given by the author as follows:

In the beehive oven a shallow basin 12 ft. in diameter is filled with coal to the depth of 24 ins. As it gradually fuses into coke, the mass swells to a height of about 30 ins. If, on quenching, it falls back to about the original bulk, it makes a hard coke. If it does not, it makes a soft

*"Proc. of Eng'rs' Soc. of Wn. Pa., March, 1896.

coke. This is the apparent difference between the Connellsville coke and the other coke from the Pittsburg vein.

Consider this operation in the retort oven, which is a narrow chamber about 18 ins. wide and 6 ft. high. When the coking coal swells it cannot expand. It is compressed laterally between the narrow oven walls, and vertically by the overlaying weight of over 5 ft. of coal. The result is that the coke which is soft when coked in beehive ovens is hard when coked in retort ovens.

Further, the hydro-carbon gases, escaping through the mass of the coke in the beehive oven, form vertical passages or cells and make their way in channels like the passages in a corn-stalk or other endogenous plant. These passages are the cells of the coke structure. As they are parallel to the lines of pressure of the overlaying coal, they have free course, and assume their full size. On the other hand, in the retort oven, the volatile gases pass off first horizontally from the sides of the oven, and uniting in the central part of the mass, pass up to the outlet of the oven through a middle line of cleavage. The whole weight of the overlaying mass of coal presses upon these passages vertically, and so compresses the cells, and adds to the density of the coke. The result is therefore clearly evident that the retort oven adds density and structural strength to the coke. It will, therefore, carry a heavier burden in the furnace, both in actual height of charge, and in the proportion of ore to coke, without giving way.

This improvement in the physical quality of the coke is accompanied by a further improvement in its chemical composition. The three characteristic impurities of coke are sulphur, phosphorus and excess of ash over that required for structural strength. In the beehive oven, not only is all the surplus volatile wasted, but there is a greater or less destruction of the fixed carbon. This varies with good or poor operation of the ovens from 5% to 40%. This loss is inevitable with an internally fired oven.

On the other hand, in the retort oven, there is an actual gain in the amount of coke produced over the theoretical yield of the coal in the fixed carbon and ash. This gain is caused by breaking up the hydro-carbon gases and the deposit of graphitic carbon on the surface of the coke. This gain amounts to from 5% to 15% over the ordinary practice of beehive ovens.

In proportion as the product of coke from the retort oven exceeds the product from the same coal in the beehive oven, the amounts of sulphur, phosphorus and ash in the retort coke will be decreased, since these impurities start from the coal, and remain, to a large extent, in the coke.

We may therefore sum up the effect of the coke oven construction on the resulting coke as follows: The yield of coke will be increased by the greater rapidity of coking, which never exceeds 24 hours, and may often require only 18 hours, and also in coking part of the volatile matter. Second, the quality of the coke is improved chemically, by reducing the impurities, and physically by increasing the structural strength of the coke.

Considering the Fourth Pool coals as tributary to the Pittsburg and Valley region, the coals of the upper Monongahela and West Virginia as tributary to the blast furnaces in the Ohio valley; the Western Maryland coals as tributary to the Eastern Pennsylvania and Maryland furnaces; and the Pocahontas coals as tributary to the Virginia and Western furnaces—these results are of fundamental importance. The improvement in the quality of the coke produced should raise the value of the coke by at least 25%, and the increase in the product of coke, which may be fairly stated from the present common practice as 20%, is equivalent to a profit of 20% over that obtained by present methods. For every five tons of coke produced by present practice, one additional ton will be produced by means of the retort oven, and this extra ton requiring no extra mining or manipulation up to the time of shipping, is all profit.

Still, it must not be forgotten that no oven will make good coke out of poor coal. The fountain cannot raise higher than its source. I have no doubt that the retort oven will produce coke better than Connellsville, from coals that are better than Connellsville, if such can be found. The test of 1,500 tons of Semet-Solvay coke from Connellsville coal at the Buffalo furnace demonstrated conclusively that a coke which did not represent the best practice of the retort oven was equal in the blast furnace, both in calorific power, in burden bearing, and in the quality and amount of the iron produced, to the best, selected 72-hour coke that the Connellsville region was able to offer.

FIG. 4.—WRECK OF POWER HOUSE OF THE SCULLIN ELECTRIC RY.; PART OF DEBRIS REMOVED FROM MACHINERY.

(The Chimney was 162 ft. high and 18 ft. diameter at the Base. The Part Still Standing is About 40 ft. High.)

Comparison of Results of Retort and Beehive Ovens.

For the purpose of the comparison assume a Connellsville coal having the following analysis:

Volatile matter	31.9%
Fixed Carbon	61.6%
Ash	6.5%

This coal coked in the retort oven yields 76.6% of large coke and breeze (dry), and 9,250 cu. ft. of gas. The same coal coked in the beehive oven yields, say 65% of dry coke and breeze and no gas.

The 76.6% yield of coke from the retort oven contains as follows:

Analysis of Coke.		Lbs. per ton Coal.
Volatile	1.92%	29.41
Fixed Carbon	88.21	1351.38
Ash	9.87	151.21
	100.00	1532.00

It is plain that whatever may be the yield of coke in any oven from a certain coal, the pounds of ash per ton of coal must be the same; therefore, assuming the same volatile in the beehive coke as in the retort coke the 65% yield from the beehive oven will give a coke of the following composition:

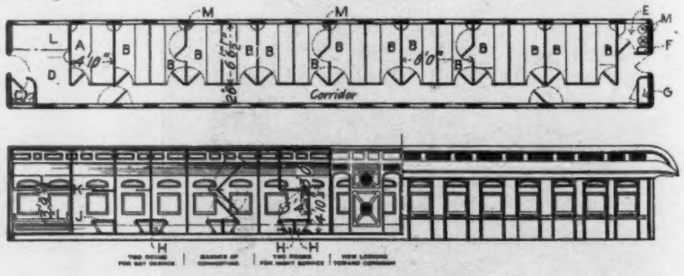
Analysis of Coke.		Lbs. per ton Coal.
Volatile	1.92%	24.96
Fixed Carbon	86.45	1123.83
Ash	11.63	151.21
	100.00	1300.00

THE LOCKWOOD STATEROOM SLEEPING CAR.

The desire for more privacy in sleeping cars than is obtainable in the ordinary sleeping car, with its curtained berths, has led to the introduction of stateroom cars to a limited extent, these cars usually having a side aisle or corridor upon which open the individual staterooms. These cars, however, are run only upon a few trains, for which extra fares are sometimes charged, and as the staterooms have always at least two berths, they are not available for a passenger traveling alone. A new style of stateroom sleeping car has recently been designed by Mr. C. L. Lockwood, in which each room has but a single berth, while adjacent rooms can be connected by unlocking a door in the partition if two or more persons are traveling together.

The accompanying cut represents the arrangement of the rooms and berths, from which it will be seen that during the day the rooms have the usual arrangement, while at night the alternate partitions are moved in such a way that the upper and lower berths are in alternate rooms. By day each stateroom is 6 ft. 6½ ins. long and 4 ft. wide, and has a sofa 19¼ ins. wide. At night the upper part of each movable (alternate) partition is unfastened, slid forward 19¼ ins. in grooved guides and refastened. The lower part of the partition is then raised and locked in a horizontal position, forming the bottom of the upper berth. An additional partition, which forms the top of the double seat, is then thrown up vertically, and forms the back of the lower berth. For parties, two staterooms can be arranged with one lower berth only in each, or with both berths opening into the same stateroom. No curtains are required. The width at night is 5 ft. 8 ins. over the berths, which, as will be seen, are placed crosswise of the car. Each room has a washstand, and has regulating ventilators opening into the corridor. In the cut, A is a double stateroom, with two berths; B, B, are 14 single staterooms, with one berth in each; C, men's closet; D, smoking room; E, women's closet; F, water tank; G, porter's cupboard; H, lockers; J, single berth (stationary); K, single berth (drop); L, L, two ordinary berths; M, M, washstands.

A Lockwood sleeping car, 72 ft. long, will have 14 single staterooms, one double room and two ordinary berths, or 18 berths in all; while a 60-ft. would have 15 berths in all. It does not afford as many berths as the ordinary Pullman or Wagner cars, which is practically impossible where a separate room is given to each passenger, but as the berths are wider than those of ordinary cars, two persons traveling together can comfortably sleep in one berth. The object aimed at has been to obtain separate rooms with as little sacrifice of space as possible. The discomforts and annoyances to which passengers are subjected in an ordinary sleeping car, occupied to its full capacity, are familiar to all travelers, and these annoyances are due mainly to the confusion and publicity, the poor ventilation, the narrow aisle between the curtained berths, the small space available for dressing, the awkward access to the upper berths, and the inadequate accommodation of the toilet rooms. The designer has submitted plans to experienced builders, and states that the construction has been pronounced both simple and practicable, and that the cost would be several thousand dollars less than that of the ordinary sleeping cars. This reduction could probably be easily made by abandoning the excessive and meretricious decoration which disfigures most of the Pullman and Wagner cars. The patents of the car above described are owned



THE LOCKWOOD STATEROOM SLEEPING CAR.

by the Lockwood Stateroom Sleeping Car Co., of Cincinnati, O., of which Mr. C. L. Lockwood is the Vice-President, and we are indebted to the President, Mr. J. W. Shrague (P. O. Box 519, Cincinnati, O.), for particulars of the car.

RECENT IMPROVEMENTS IN HOISTING MACHINERY.

A member of our staff recently visited the works of the De La Vergne Refrigerating Machine Co., at foot of 138th St., East River, Port Morris,

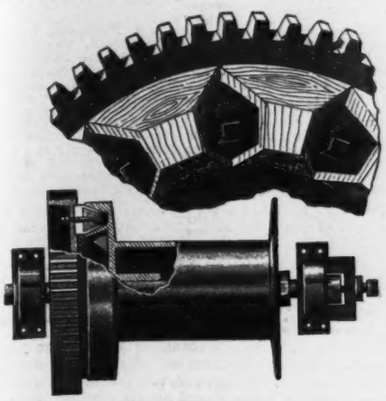


Fig. 1.—Friction Drum. Gust. Pers. Wern's Patent. Built by the De La Vergne Refrigerating Machine Co., New York.

New York city, and in addition to work upon refrigerating machines, for which the concern is most widely known, he found a great variety of work of other kinds in progress, such as the building of Corliss engines, two water-works pumping engines, a large cotton press, steam boilers, petroleum and gasoline engines, etc. The establishment has grown to be one of the largest machine shops in the country, and it is equipped with machines capable of handling the heaviest class of work. A department which has lately been added to the company's business is the manufacture of hoisting engines. A catalogue of those engines shows a number of varieties and sizes, most of them of the usual form, with horizontal cylinders geared to a drum, with friction cone clutch; but special engines are also built, one of which, designed for a floating derrick, is shown in the catalogue. It is said to be the largest hoisting engine ever manufactured for this purpose, having a capacity to lift a load of 260 tons. It has three drums, two 36 ins. and one 72 ins. in diameter, grooved for 1⅝-in. wire rope. Each drum is driven independently by a duplex engine, the cylinders of which, for the smaller drums, are 10×16 ins., and for the larger drums 14×16 ins.

The hoisting engines are fitted with the friction

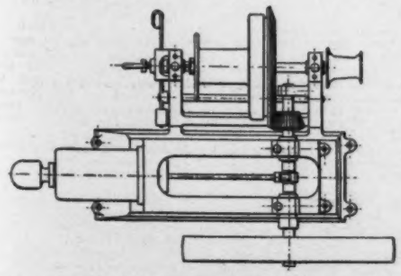


Fig. 2.—Hornsby-Akroyd Oil Engine Coupled to a Hoisting Drum.

cone, which we illustrate in Fig. 1. It is patented by Mr. Gust. Pers. Wern, the superintendent of the hoisting engine department of the company. As seen in the cut it presents the end grain of the wooden blocks to both the inner and outer faces of the cast-iron friction groove. The wooden surface not being continuous, the blocks are air-cooled. If the wood shrinks, the wedge-shaped blocks on being tightened, by the bolts and nuts by which they are attached to the drum, force the blocks apart, and act as binders, preventing the wood from splitting. It is claimed that the friction clutch will outlast any hoisting engine, and that on account of the hard end grain of the wood the cone always keeps a true circular form, therefore, less lateral motion of the drum is required to engage or disengage it. The blocks are interchangeable and can readily be applied to any hoisting engine drum.

One of the novelties recently introduced by the De La Vergne Refrigerating Machine Co. is the Hornsby-Akroyd oil engine, which uses ordinary kerosene. Its chief feature is an extension to the cylinder, in which the combustion of the spray of oil takes place. This extension becomes red hot shortly after the engine is started, and it acts to vaporize and ignite the oil and promote its complete combustion. One adaptation of the oil engine is for hoisting, and the cut Fig. 2 shows a plan view of the engine attached to a hoisting drum by means of bevel gearing and the friction cone already described.

Another of Mr. Wern's inventions in the line of hoisting apparatus is the reversing friction gearing, shown in Fig. 3. The apparatus shown in the cut is an application of this mechanism to drive an endless rope for elevators or conveyors. A is the driving shaft, which may be either a gas engine, a steam engine or a line shaft, which drives the spur gears B, C and D, C being an idler so placed that it causes D to turn in the opposite direction from B. E and F are compressed paper cones, and G a cast-iron cone, which is caused, by moving the handle H, to come in contact with one cone or the other, reversing the motion, or to take a position between the two, in which it remains at rest. I is a lever, moved by the foot,

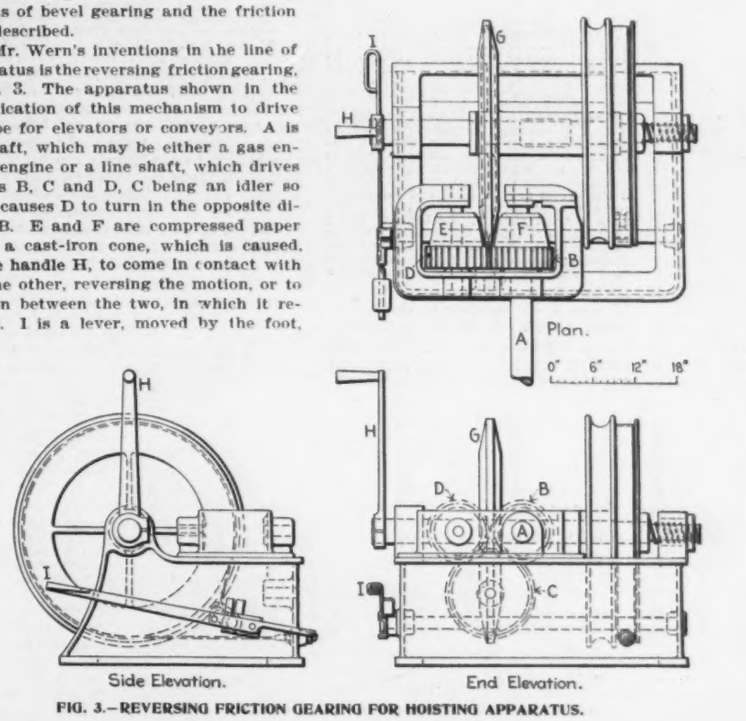


FIG. 3.—REVERSING FRICTION GEARING FOR HOISTING APPARATUS.

which operates a band brake. The whole apparatus seems to be a very compact and efficient device for the purpose for which it is intended.

RAISING CROPS ON SEWAGE FILTER BEDS.

Sewage farming has been extensively carried on in Europe for many years, and recently some attempts in that direction have been made here. A large variety of crops have been tried in this country, many of them with apparent success. In the West (see Engineering News, Feb. 23, 1893) sewage has been used more as a substitute for water in irrigation than for its value as a fertilizer, and promising results have been reported, providing the best agricultural skill and business judgment and enterprise were devoted to the management.

Experience at Pullman, Ill.

For many years Pullman, Ill., was cited as practically the only example of sewage farming in this country. So far as we can learn, and we have taken no small pains to ascertain the truth, the raising of crops at Pullman has been made of more importance than the purification of sewage.*

But probably enough was done at Pullman to give some indication of what might be expected from similar soil and climate elsewhere in this country. It is stated that the most satisfactory results at Pullman were obtained with cabbage, cauliflower, celery, asparagus, onions and sweet corn. Potatoes were classed as a failure and Italian rye-grass grew so rank as to be nearly worthless.

The above relates more especially to so-called sewage farming where the sewage is applied on the broad irrigation plan.

Raising Crops on Filter Beds.

At Berlin, Ont., and South Framingham, Mass., crops have been raised for a few years past on filter beds. Such beds are designed to receive sewage in much larger quantities per acre than irrigated areas. The rates of application are not at hand for either place, but Mr. John H. Goodell, Chairman of the Sewerage Committee of the Town of Framingham, states that the raising of crops does not necessitate a reduction in the amount of sewage applied to the beds. A large area of land is available at South Framingham and possibly the rate of application is small.

Results at Berlin, Ont.

At Berlin crops were first tried in 1893 or 1894.* Cabbages were successfully raised, but Italian rye-grass did not give satisfactory results. On rather less than one-half acre 2,000 cabbage plants were set out, about 1,500 of which grew to marketable heads and were sold without difficulty at the regular market price of 3 cts. each.

The cabbages were irrigated regularly and grew well, though no attempt was made to hoe around them or hill them up, the bed being left smooth, exactly like the others.

The Italian rye-grass seed was sown broadcast upon a part of one of the beds, and soon came up and covered the ground with a mass of roots that very much retarded the absorption of sewage. Mr. Herbert J. Bowman, Town Engineer, states that Italian rye-grass prevents all work on the land, so that any depressions in the ground may soon become foul, and that it was decided to be a failure. Abroad this a very common crop, held to be especially desirable because of the great amount of sewage it will stand, as compared with other crops, and the large tonnage of grass per acre which may be secured. But in Europe this and other crops are not raised in beds and the land is so prepared and the sewage so applied as to avoid all pondage as far as possible, besides which the dosing is regulated to the crop and land. Apparently the bed with the rye-grass at Berlin was dosed much the same as those with-

*See Engineering News for Jan. 12, 1893. During 1895 a representative of this journal visited the Pullman disposal area, but could learn little in addition to the information previously secured.

*For description of the Berlin disposal area see Eng. News, April 6, 1893.

out crops. All the cabbages were good, except that very sandy soil stunted some of them.

In 1895 a large number of cabbage plants were put in at Berlin, but the early frost killed most of them. Later, more cabbages were set, and seed was put in for onions, carrots, mangels, corn and beans. On Aug. 8, 1895, Mr. Bowman wrote that all these crops seemed to be doing well except the corn and beans, which he stated were not adapted to wet soil.

On Dec. 17, 1895, Mr. Bowen kindly gave us a summary of the crops raised and the proceeds derived from their sale, with a few words of comment, as follows:

The following account of sale of produce from the Berlin sewage farm in 1895, has been compiled from the proceedings of the sewerage committee of the town council which has charge of the farm:

August,	1,217 heads cabbage @ 2½c.	$30
September,	1,771 " " " "	44
October,	2,272 " " " "	57
"	134 bu. carrots @ 15c.	20
"	648 " mangel-wurtzel @ 15c.	97
"	corn (failure)	7
"	peas (not irrigated to any extent)	15
November,	1,350 heads cabbage at 2½c	34
		$304

In addition to the above, Mr. J. M. Staebler, Chairman of the Sewerage Committee, informs me that he had 150 kegs of sauerkraut, made from cabbage not sold. These kegs hold 50 lbs. each, and are being sold at $3 each, but so far only a few have been sold. However, if a market is found for this dainty of the Fatherland, the receipts from the Berlin sewage farm will more than pay for cost of operating.

The mangels were a great success, the 648 bu. being taken off about one-half acre, and were easily sold to farmers for feeding stock. They will stand any amount of sewage, which cannot be said of cabbages, which are also hard to dispose of, as with our 8,500 population the demand is not very great.

Results at South Framingham, Mass.

Crops have been raised on the filter beds at South Framingham for at least five years. The report of the Sewer Committee for the year ending Feb. 29, 1892, contains the following reference to the attempts along this line made in 1891:

Some experiments have been made the past year in raising crops at the irrigation field, and enough has been accomplished to convince your committee that quite an income can be derived by the town from this means; and your committee believes that the raising of crops should be increased from year to year as the condition of the ground will admit of it. This can be done with little or no extra expense.

In 1892 about 400 bu. of corn, three-fourths of an acre of cabbages and some squashes were raised and sold for $174. In 1893 corn, squash, beans, potatoes and cabbage were raised, and brought $234. The report for this period states that under the town regulations the crops had to be sold at public auction, thus yielding "much below their value, by reason of the uncertainty of just how much each bed would yield." The results obtained in 1894 are set forth and commented on in the report of the Sewer Committee for 1893-4, as follows:

The crops the past season were more abundant than any former year. There were raised about nine acres of field corn on the several beds which was sold standing at public auction for the sum of $435. The result was far beyond our expectations, and we have yet to hear of better results in raising corn on this amount of land by the most experienced farmers.

Your committee at the suggestion of a member of the State Board of Health raised a small quantity of tobacco which proves very satisfactory. This tobacco has been stripped and packed in cases, but owing to its peculiar nature no estimate of its worth can be obtained until it has been through the sweating process.

Your committee proposes to put in one acre this year (1895—Ed.), and if the results prove as we anticipate, it will, we believe, prove a paying crop as well as leaving (being?) a powerful absorbent.

Under date of Dec. 31, 1895, Mr. John H. Goodell, Chairman of the Sewer Committee, kindly gave us the following information regarding crops raised in 1895 :

Your favor of Dec. 16 received. In reply I will say that when our system of sewage disposal was constructed no thought of raising crops was entertained, but the sewer committee have experimented in raising various crops, such as potatoes, cabbages, squash, cauliflower, rye-grass and timothy, field corn and tobacco, and from our observations we find that field corn and tobacco are the only ones that we can profitably raise; not that the other crops cannot be satisfactorily grown, namely, cabbage and squash, but sensitive people object to using them by reason of their having been raised on sewage land. In my judgment they are just as healthy and palatable as if raised on ordinary farm land. Common field corn grows very rapidly and enormous crops can be raised on sewage land. The past season we have raised twelve acres of field corn and one acre of tobacco, and it is my opinion that the corn would average 100 bu. of shelled corn to the acre. The corn sold at auction, standing, for about $400. The lot of tobacco we cure in the ordinary way. There are 800 connections with our sewerage system up to date.

The prejudice against root crops and cabbages raised on a sewage disposal area is natural enough, however ill-founded it may be. Doubtless it could be overcome in time, while by reaching out beyond the local market there might be no trouble whatever.

In response to a request for information regarding the effect of crops upon the operation of the beds, Mr. Goodell wrote on Jan. 9, 1896, as follows:

The raising of corn on our filter-beds does not interfere in the least with the volume of sewage. The beds are capable of caring for the sewage and the sewage keeps the land nearer its normal condition.

If any of our readers can give further information regarding the raising of crops on sewage disposal areas in this country, we shall be pleased to hear from them.

BOOK REVIEWS.

COKE: A TREATISE ON THE MANUFACTURE OF COKE AND THE SAVING OF BY-PRODUCTS.—With Special Reference to the Methods and Ovens best adapted to the Production of good Coke from the various American Coals. By John Fulton, E. M., M. Am. Inst. M. E., etc. Scranton, Pa.: The Colliery Engineer Co. 1895. Cloth; 8vo.; pp. 342. $4.

Mr. Fulton has had 20 years' experience in the line of work of which the volume treats, in his official positions as General Mining Engineer and General Manager of the Cambria Iron Co., and for many years he has been considered the leading coke expert in this country. In this book he has brought together a great amount of valuable information derived from his own experiments, together with an excellent digest of recent literature on the subjects of modern methods of preparation of coal for coking, of the recent styles of coke ovens, and of the various methods of saving of by-products. It is the only American treatise on the subject, and will be invaluable to those interested in it. The manufacture of coke is now in a transition stage. New varieties of coke ovens are about to be experimented with in the United States, which have been in successful operation for some years in Europe, and the problem of coking a great variety of coals which have not hitherto been considered as of coking quality remains to be worked out. There is a great deal yet to be learned about the coking of these coals, and the author clearly shows the difficulties which are to be encountered. The book is very fully illustrated, and the operations of the various ovens and other apparatus are described in great detail. Mr. Fulton deserves the thanks of the profession for his most valuable contribution to the literature of the subject.

CHEMISTRY FOR ENGINEERS AND MANUFACTURERS.—A Practical Text-Book. By Bertram Blount and A. G. Bloxam. With Illustrations. Vol. I. Chemistry of Engineering, Building and Metallurgy. London; Charles Griffin & Co.; Philadelphia; J. B. Lippincott Co. 1896. 12mo.; pp. 244. $3.50.

In their preface the authors state that they have chiefly had in view the needs of practising engineers, managers of works and technical students desirous of obtaining some knowledge of chemical technology. In their very limited space they have attempted to cover a vast field, including the chemistry of materials of construction, of fuels, of waters, of lubricants, and the metallurgy of iron, copper, lead, zinc, tin, mercury, silver, gold, etc. The work may be of some value to technical students who desire a mere smattering of knowledge of these numerous subjects, and may be handy for occasional reference by those who are not possessed of more elaborate treatises, but it is too much condensed to be of great service to engineers engaged in any particular speciality. For instance, the metallurgy of iron covers 24 pages, and that of copper only 15. The book appears to be chiefly a compilation, and in some respects not a judicious one. The authors are apparently not experts in some of the branches of which they treat. As samples of inaccurate statements the following may be noted: "Tinned iron (tin plate) is not much used as a structural material (except for roofs, for which it is ill-adapted)." "At higher temperatures, e. g. 300° to 400°, the tensile strength (of metals) is greatly reduced. But few exact data dealing with this matter have been published." This is far from true, as regards iron and steel. On the whole the book is a rather poor production.

STEEL.—A Manual for Steel Users. By William Metcalf, Past-President Am. Soc. C. E. New York: John Wiley & Sons, 12mo., cloth, pp. 169; $2.

This little work is written by a steel manufacturer of 27 years' experience. Mr. Metcalf was the leading practical partner of the old firm of Miller, Metcalf & Parkin, now the Crescent Steel Works, of Pittsburg, Pa., one of the largest crucible steel works in the world, and what he has to say in this book is the result of his own experience and scientific study of the hundreds of problems that are continually presented to the maker and user of crucible steel. It is written in a style which the ordinary steel user can easily understand. We quote the following from the preface:

The literature of steel has grown with the art; its books are no longer to be counted on the fingers, they are to be weighed in tons. Then why write another? Because there seems to be one little gap. Metallurgists and scientists have worked and are still working; they have given to the world much information for which the world should be thankful. Engineers have experimented and tested, as they never did before, and thousands of tables and results are recorded, providing coming engineers with a mine of invaluable wealth. Steel-workers and temperers have written much that is of great practical value. Still the questions come, and they are almost always those involving an intimate acquaintance with the properties of steel, which is only to be gained by contact with both manufacturers and users. In this little manual the effort is made to fill this gap and to give to all steel users a systematic, condensed statement of facts that could not be obtained otherwise, except by traveling through miles of literature, and possibly not then. There are no tables, and no exact data; such would be merely a re-compilation of work already done by abler minds. It is a record of experiences, and so it may seem to be dogmatic; the author believes its statements to be true—they are true as far as his knowledge goes; others can verify them by trial.

An example of the author's easy style of writing is the following:

The successful steel-maker must familiarize himself with the personal equations of his patrons. One man on the sunny side of the street may be making an excellent tool from a certain grade and temper of steel, and be perfectly happy and prosperous in its use. His competitor on the shady side of the street may fail in trying to use the same steel for the same purpose and condemn it utterly. The know-it-all agent will condemn the latter man with an intimation that his ears are too long, and so lose his trade. The tactful agent will supply him with steel a temper higher or a temper lower, until he hits upon the right one, and so will retain both men on his list; and both men will turn out equally good products.

This book is the best work on the treatment of crucible steel of which we have any knowledge; it should be in the hands of every steel user.

GENERAL SPECIFICATIONS FOR RAILROAD AND HIGHWAY BRIDGES, ROOFS AND BUILDINGS. 1896. Issued by the Baltimore & Ohio R. R., Baltimore, Md. W. T. Manning, M. Am. Soc. C. E., Chief Engineer; J. E. Greiner, M. Am. Soc. C. E., Engineer of Bridges. Paper; 6×9 ins.; pp. 35.

The B. & O. bridge specifications have become pretty well known among engineers, and the appearance of a new edition with many changes and additions is a noteworthy matter. We are indebted to Mr. Greiner for the following excellent summary of the changes which have been introduced in this year's edition of the specifications:

Sir: The B. & O. specifications for 1894 covered nothing but simple railroad bridges and necessitated special specifications for draw-bridges, buildings and highway bridges. The 1896 specifications, however, include drawbridges, highway bridges, roofs and buildings. The table of contents on p. 35 gives the subject matter of each article and these articles are arranged so as to be most readily found by those called upon to use the specifications. These specifications appear to the writer to be complete, and it adhered to will give a first-class structure, the details of which are in keeping with the heavy train loads.

You will note that the writer has used a somewhat different engine than that called for in the previous specifications, although the total weight is the same. The present engine is identically the same as the one used by Mr. Wilson in his specifications of 1891 and was adopted by the author because it represents about the greatest concentration which can possibly obtain in actual service for consolidation engines weighing 82 tons, without tender, and for the further reason that by abandoning the engine called for in the 1894 specifications and adopting an engine which is already largely specified, there is one less typical engine to bother engineers.

You will note also that the unit streases have been simplified and no distinction is made in tension between the forged eye-bars and built up tension members. Formerly engineers strongly favored the eye-bar and allowed a much higher working stress on this kind of tension member than they were willing to allow on the member built up of plates and angles. During the past few years, however, the feeling in this respect has been modified and the tendency at the present time is to allow just as high unit stresses on the built-up tension members as is allowed on the forged eye-bars, because plates and angles of moderate sizes contain just as good material as is placed in eye-bars and the metal will be uninjured when workmanship is carried out as called for, and for the further reason that such members are stiff and eliminate vibration to a considerable extent, thereby lessening the secondary strains due to vibration which are always present in tension members composed of a single bar.

There are but two kinds of tension stresses and two kinds of compression stresses considered, the first being due to a direct live and dead loading and the second being due to wind, centrifugal force or momentum of train. Those due to the first class consider an allowance for impact and those due to the second class require no such allowance, as the actual forces are known.

There are other changes in these unit stresses which will be readily observed upon comparison with our 1894 specifications. The unit stresses for timber are also given and you will please note that the formulas for columns over 17 diameters are very simple and are based upon the results of all tests made up to date, the main difference between these formulas and the numerous others being that the unit stresses decrease more rapidly as the value $\frac{l}{d}$ of — increases. The object of this is readily understood from the fact that long timbers contain more defects than short ones, and that timber when first placed in a structure is usually fresh, and one side of it being exposed to the sun becomes more or less warped as it seasons.

In section 117 you will note that the different cases for the calculation of swing bridges are about the same as usually specified, but that in combining these cases for the total maximum stresses the writer considers that those members which receive their maximum live load stresses when load covers both arms, should be combined with case 2, dead load when bridge closed, or by taking case 1 alone, care being taken to satisfy both conditions without exceeding the specified unit stresses.

Under Article VIII., "workmanship," Section 146, you will observe that members made of soft steel over ⅝ in. thick and medium steel with a thickness less than ⅝ in., may be punched and annealed instead of being drilled, at the option of the contractor.

Under Article IX., painting, the 1896 specifications call for three coats of paint instead of two, called for in the 1894 specifications, and the field coats are of a gray color to be manufactured from pure lead and zinc. The previous specifications call for red lead paint mixed with lamp black, but it is desired to give the bridges a neater appearance than can be obtained by red lead and lamp black, hence the adoption of the gray color.